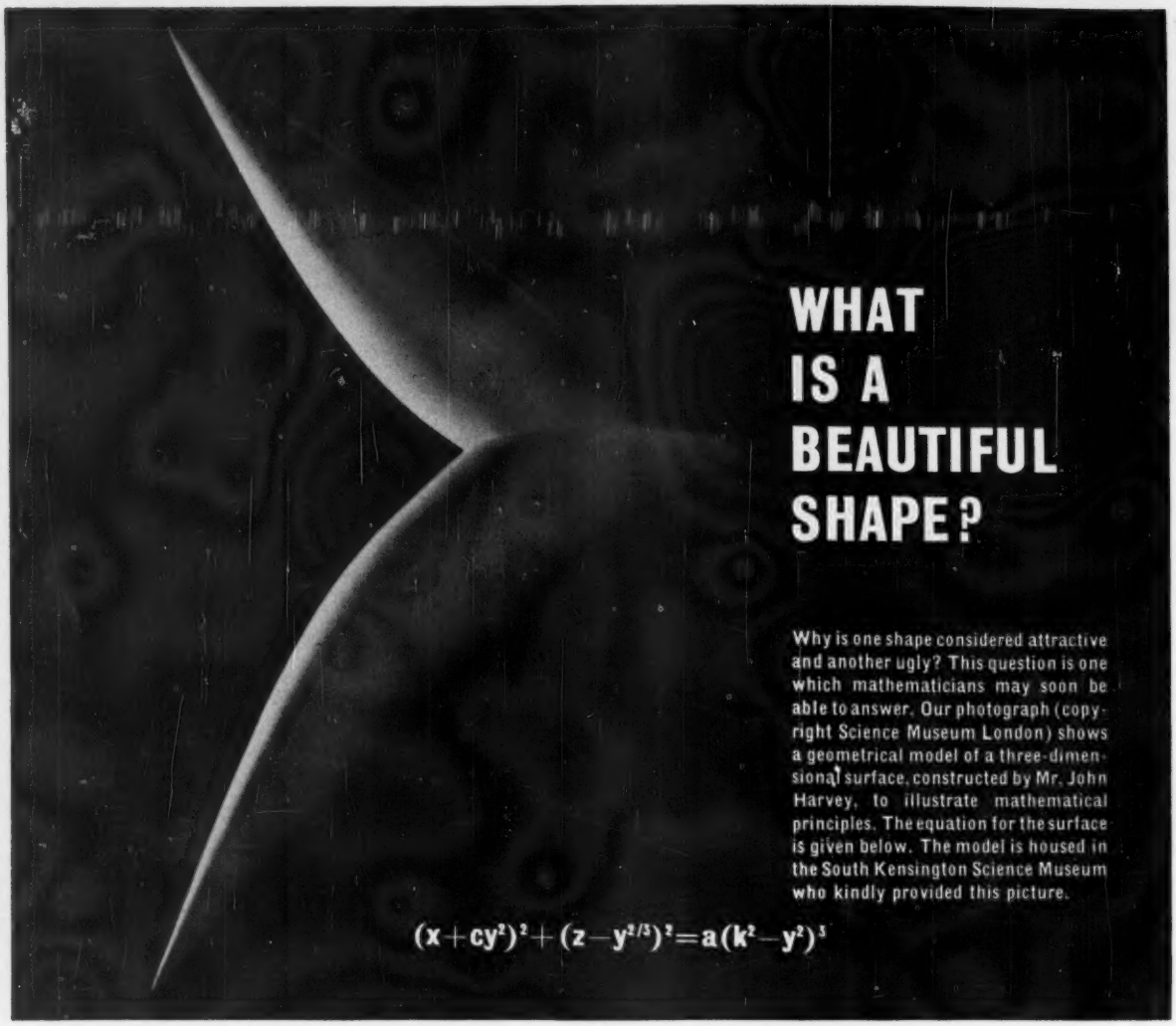
DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

NOVEMBER 1958 2/6

THE COMET IV



WHAT IS A BEAUTIFUL SHAPE?

Why is one shape considered attractive and another ugly? This question is one which mathematicians may soon be able to answer. Our photograph (copyright Science Museum London) shows a geometrical model of a three-dimensional surface, constructed by Mr. John Harvey, to illustrate mathematical principles. The equation for the surface is given below. The model is housed in the South Kensington Science Museum who kindly provided this picture.

$$(x+cy^2)^2+(z-y^{2/3})^2=a(k^2-y^2)^5$$

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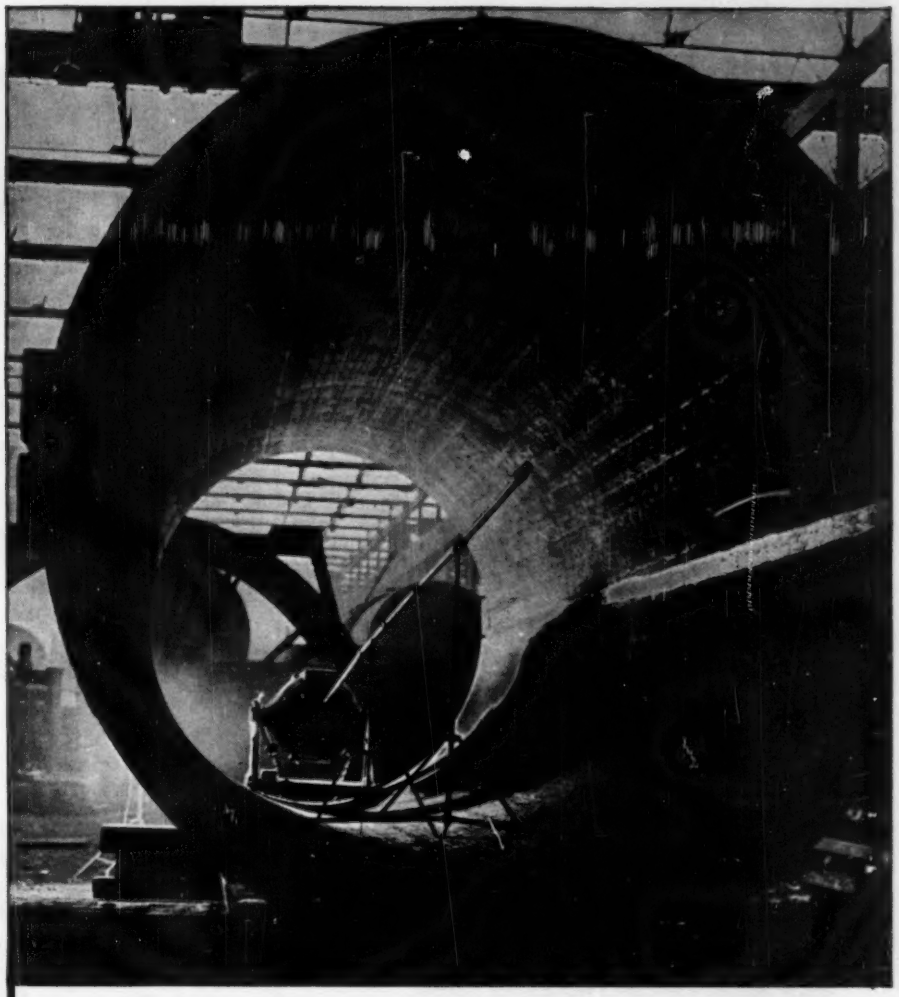

Using a radio-isotope (contained in the axial tube) to radiograph the welded seams in a cylindrical pressure vessel. Ilford Industrial X-ray films, held in flexible cassettes, are attached to the outside of the cylinder. Reproduced by courtesy of G. A. Harvey & Co. (London) Ltd.

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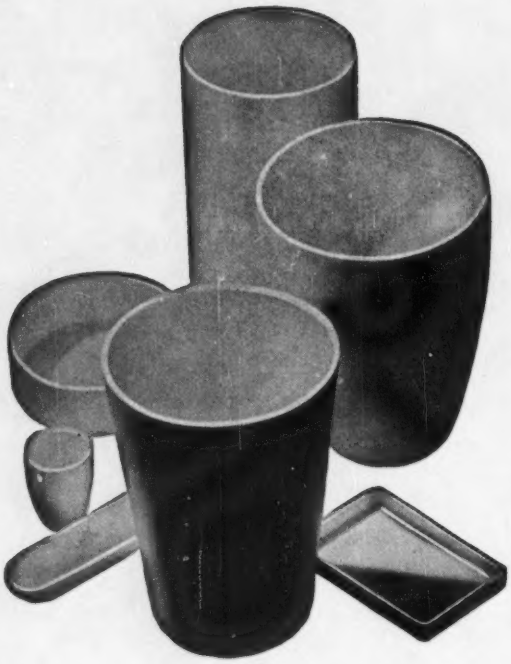

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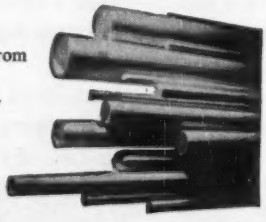

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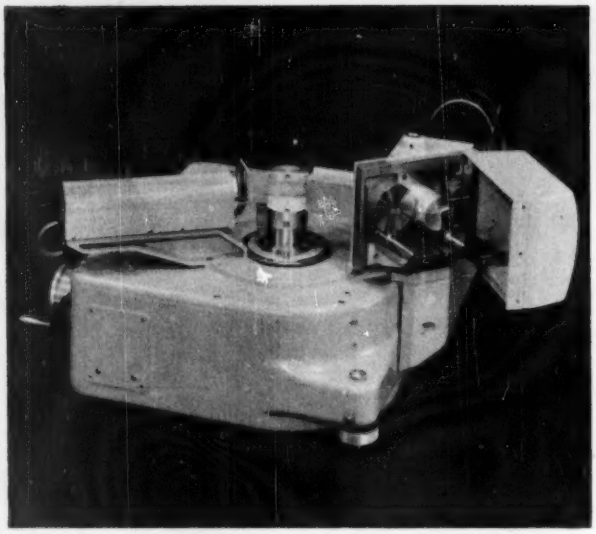

Penetrating analysis

The principle of analysis by X-ray fluorescence is simple: when a substance is irradiated with an intense beam of X-rays, it fluoresces with its own characteristic X-ray spectrum, from which its composition can be determined. The analysis is equally simple to perform: the sample is placed in the instrument, and each of its constituent elements determined in turn; the results are printed on a sheet of paper. The printed figures represent the relative concentrations of the elements in the sample. The analysis takes two or three minutes to perform, and is usually non-destructive. The method is therefore ideal for routine analysis of small finished components as well as for checking the specification of raw materials, such as alloys.

¶ The illustration shows a simple X-ray fluorescence spectrometer that is especially suitable for research and experimental work. On the right of the picture is the X-ray tube and sample-holder. Rays from the sample are reflected at various angles by the crystal seen at the centre of the picture, and detected by the detecting-head on the left.

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Anthony R. Michaelis, PH.D., B.SC.

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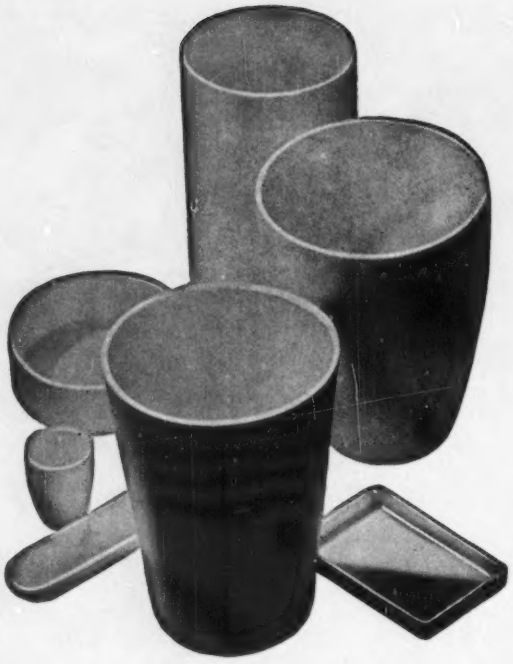

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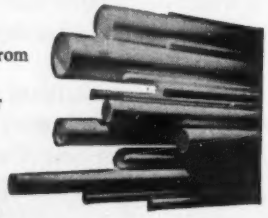

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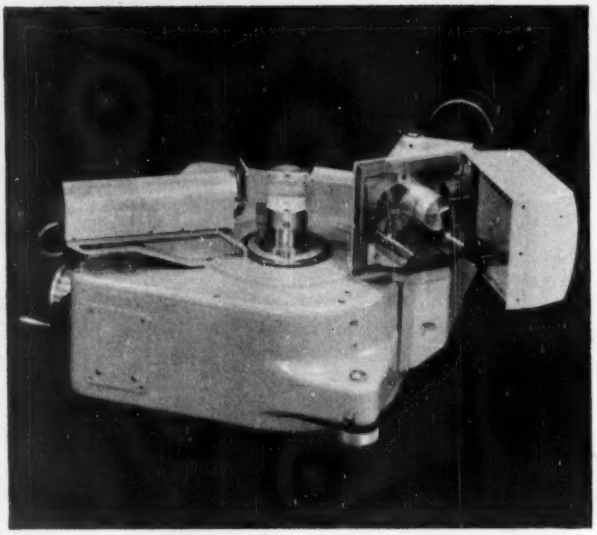

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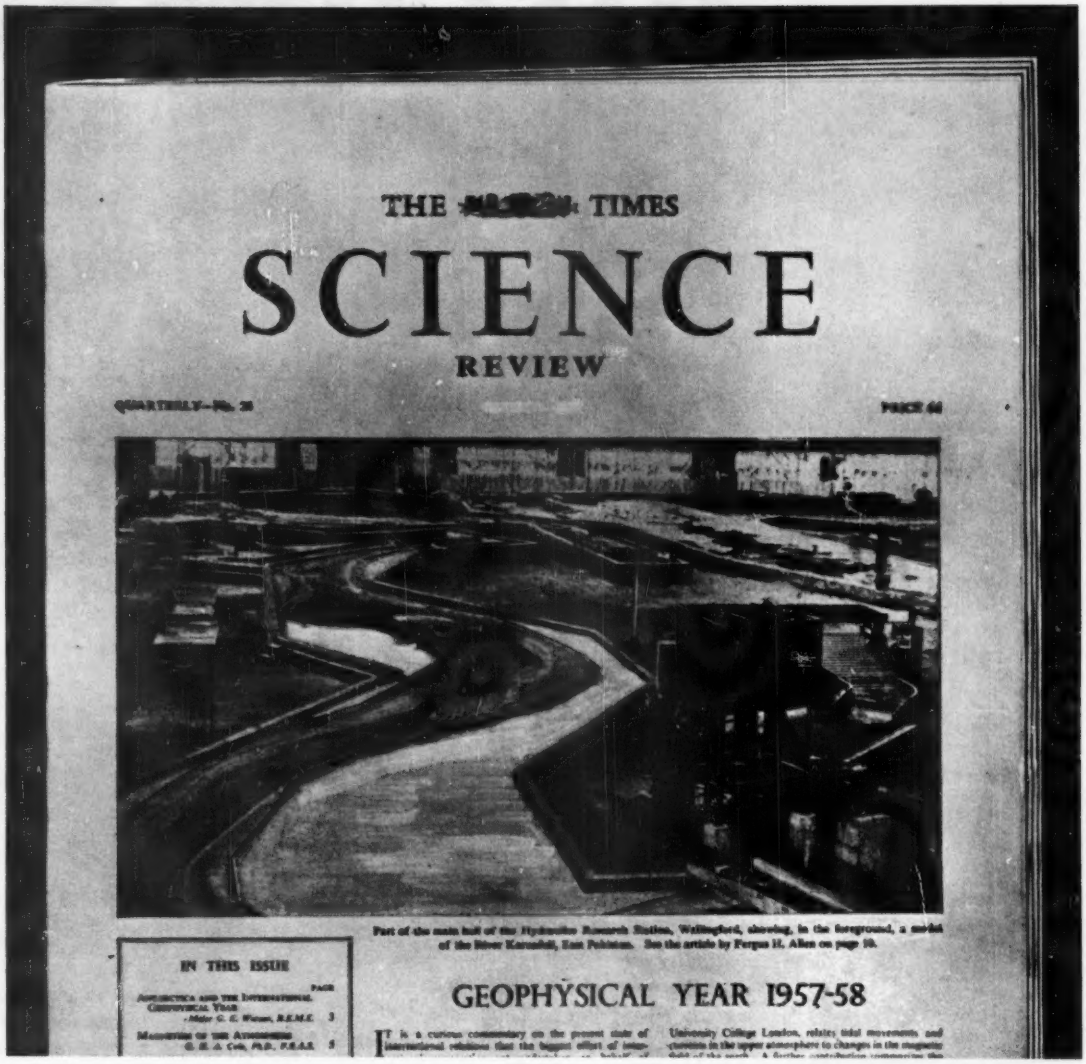

THE [redacted] TIMES

SCIENCE

REVIEW

QUARTERLY—No. 20 PRICE 6d

Part of the main hall of the Hydraulics Research Station, Wallingford, showing, in the foreground, a model of the River Karnafuli, East Pakistan. See the article by Fergus H. Allen on page 10.

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GEOPHYSICAL YEAR 1957-58

It is a curious commentary on the present state of international relations that the biggest effort of inter-

University College London, relates tidal movements and currents in the upper atmosphere to changes in the magnetic

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the plant of Antarctica at the I.G.Y. Dr. G. R. A. Cole, of

on the sun, the effects of these on ultraviolet radiation and

THE PROGRESS OF SCIENCE

TOMORROW'S ENERGY

Our perspective of the fuel and power problem is a changing one. Hitherto, the onset of winter has focused attention on the inadequacy of the nation's immediate supplies of energy. Today, as this anxiety recedes (setting aside the danger of short-term dislocations like that caused by the Suez crisis) a far more fundamental problem emerges. Will fuel resources, in the long run, be sufficient to sustain progress, not merely in this country and Western Europe, but throughout the world? Expert assessments differ widely. The more optimistic pose the issue as one of economic growth creating a problem of fuel supplies for science to solve; the more pessimistic point to the future of fuel supplies as the primary limiting factor which should in turn determine our economic policies. Though no one can be sure which view is more plausible, for the elements are too varied and the imponderabilia too great, a more precise picture of the problem is albeit emerging from the more authoritative assumptions which have been made.

A growing economy needs growing supplies of energy, and given that Britain's national income could double over twenty-five years, our inland fuel consumption (exclusive of bunkers and exports) whose coal-equivalent was 245 million tons in 1954, might rise to 458 million tons by 1985. Naturally, forecasting is hazardous. There are factors such as greater success in fuel economy which could significantly depress this estimate; equally, there are factors such as unforeseen demands from extended automation, pushing the other way. At all events, the question of where such greatly increased supplies of energy are to come from is a legitimate one. For even in the most favourable circumstances, it does not look as if the coal industry, which is extracting a wasting asset, can do much better than slightly increase its present production; by 1985, it might meet only half of Britain's requirements.

What are the implications of the "gap" for the two main alternative sources of supply, oil and atomic energy? Theoretically, perhaps three-fifths of remaining needs could be met by oil. This country's demand for petroleum fuels has been rising by 8% per annum, and at this rate it is not unreasonable to foresee, again by 1985, energy supplies of over 150 million tons of coal-equivalent provided by oil. However, it is not enough to rely on expansionary achievements by the British oil industry: regard must also be had to two limiting factors. Firstly, our fuel problem cannot be viewed in a vacuum, but in relation to similar pressures for more oil in other Western European countries. Secondly, there is the economic implication, with possible political threats to our supplies, of backward areas seeking to raise living standards, reinforced by population pressures involving a growth in the world's population from 2800 million today to 5000 million people in the year 2000. Finally, there is the related question of oil reserves, variously estimated at "proved reserves" of thirty times the *present* annual rate of world production, and "recoverable reserves" of perhaps 230 years. Without adopting a cataclysmic view, we cannot take for granted an uninterrupted expansion of Britain's oil supplies in a competing world—a stabilisation-point may well be reached in the lifetime of many of our readers.

There remains nuclear power. In a swiftly changing field, estimates can be risky. The Government's latest programme provides for energy from nuclear sources equivalent to 18 million tons of coal by 1965, and anticipates considerably more than 40 million tons by 1975. A substantially greater output by 1985 is therefore feasible. Nevertheless, certain cautionary comments must be made. The expansion of nuclear power partly depends on a potential, but not yet realised, fall in generating costs; economic operational experience is negligible. Meanwhile a growing nuclear power programme demands stupendous capital investments. The whole electricity generating programme for 1955–65 amounts to £3350 million; future programmes, when they become exclusively nuclear in character, could be relatively dearer. Although the proportionate demand for electricity is growing, the major part of our fuel requirements will still be for energy other than electricity. Two conclusions may be drawn: on the positive side, nuclear power, now from uranium and in time from the lighter atoms, will provide the British economy with a desperately needed new source of energy. On the negative side, nuclear power alone will be unable to meet the full variety of our growing fuel requirements, and a dramatic new breakthrough, especially in the field of portable sources of power, is vital.

No one pretends there is a simple single remedy to this immense problem, but if remedies are to be forthcoming, greater publicity is essential to give the basic facts of the situation and to identify the key problems. The conference of the Manchester Joint Research Council on "Fuel and Power in British Industry" in November is testimony to growing public awareness. Such gatherings should ensure that the issues involved will be widely discussed and understood. For without publicity and a sense of urgency, can there be that impetus for a central policy which this problem requires? True, there is today throughout the fuel and power industries, a welcome appreciation of long-term considerations; nevertheless, the impression still created is one of haphazard advance on the broadest front, rather than of a closely knit scientific strategy. While the Ministry of Power's pattern of loose planning could be conducive to the unexpected technical breakthrough, it is not, given our scarce resources, an ideal framework. Thus, disregarding the conflicting pressures by the fuel and power industries on investment supplies, we would specially highlight the shortage of scientific manpower. How far, for example, has there been a systematic evaluation of the rival claims on skilled scientific manpower between the atomic power programme and a greatly expanded effort for the more efficient utilisation of conventional fuels? Or, to quote a recent example, how are we to reconcile the apparently opposing demands of the Atomic Energy Authority and the Central Electricity Generating Board, both bidding for atomic scientists to experiment in developing more economic nuclear power-stations? Such questions abound. Fuel and power strategy is too earnest to be denied a scientific and intensive reassessment of priorities and aims.

General view of the nuclear energy display at the Palais de la Découverte.
(Courtesy Paul Almasy, Paris)

NUCLEAR ENERGY AT THE PALAIS DE LA DECOUVERTE

The Palais de la Découverte is perhaps the most striking of the various landmarks left in Paris by the International Exhibition of 1937, for which it was created. As is indicated by its name, its founders intended it to be not just a store-house of interesting historic instruments but a museum of living science. Its aim is to awaken interest and to teach by illustrating the development of different ideas and techniques. This is done by a combination of pictures and texts, making much use of colour—the Director, Monsieur A. Léveillé, is a gifted artist as well as a mathematician—by working models and by demonstrations. As the Director is also a man of truly international outlook, stress is laid on the contribution made by scientists of different countries to each advance in knowledge.

Much importance is attached, too, to the presentation of the latest developments in science and technology, in temporary exhibitions such as the penicillin exhibition held shortly after the end of the war, or in the new room set aside to give "stop press" scientific news and in which one can find, for instance, diagrams and explanatory texts about ZETA. In line with this policy, a new hall of nuclear energy was opened recently by the Rector of the University of Paris, to which the Palais is attached. In common with most of the demonstration equipment, it was designed and constructed at the Palais under the direction of Monsieur Penel, who is in charge of the scientific, mechanical, and electrical installations.

The exhibition covers an area of 600 m.^{2}. It sets out to explain how energy is produced from the atom, showing how the raw material of nuclear energy is obtained and treated, and indicating the basic physical and chemical processes involved in the release of power. Many different illustrations are given of the applications of atomic energy, ranging from the atomic pile to the use of radio-isotopes in industry, agriculture, and medicine.

Much use is made of apparatus which can be handled by the visitor or which is operated by the two special demonstrators who are on duty permanently in the hall. For example, the visitor can work a Geiger counter which enables him to pick out from a collection of minerals those which are radioactive. Demonstration apparatus is given a special place in the nuclear physics section as an aid to making more readily understandable to the general public such complex questions as the nature of neutrons and their action on matter, including the process of fission. One particularly original piece of apparatus, which leads the visitor from fundamental nuclear physics to its application in the atomic pile, reproduces the mechanism involved in obtaining energy from the atom. In common with most of the demonstration equipment, it was designed and constructed at the Palais.

The nuclear physics section also includes two interesting models: one of the cyclotron constructed in 1938 at the Collège de France under the direction of the late F. Joliot-Curie, and one of *Saturne*, the latest French proton synchrotron which came into operation last August at the atomic energy research establishment at Saclay. *Saturne* is capable of producing protons with energies of over 3 thousand million electron volts and will be the most powerful of its kind in Western Europe until the CERN synchrotron starts working at Geneva in 1960.

There is an impressive collection of scale models of piles. One can see the first reactor constructed in France, E.L. 1 or *Zoé*, side by side with a more recent experimental reactor from Saclay, E.L. 2, and the plutonium-producing pile from Marcoule. The U.S.A. has contributed three models as well as a beautiful colour panorama of the swimming-pool reactor of Oak Ridge. Canada is represented by an experimental pile from Chalk River, and the U.S.S.R. has sent two particularly fine models, one in transparent plastic of an experimental heavy water reactor and the other of a pile for the production of electric power. Finally, there is an attractive model of Calder Hall; the model of Dounreay, which the UKAEA loaned to the Palais for the first month, had to be withdrawn later for exhibition elsewhere.

In the section of the exhibition devoted to the applications of radio-isotopes, working models show how, in industry, α-, β-, and γ-rays are used to test different types of material, to find out the level reached by a liquid in an opaque container, and so forth. Illustrations are given of the use of trace elements to study the metabolism of plants and animals. The contribution of radioactive substances to medicine, in the diagnosis and treatment of cancer in particular, is shown by photographs, films, and models. There is one specially clear demonstration, on models of human heads, of the way in which the exact position and size of cranial tumours can be determined before the skull is opened up, making it possible to reduce both the duration and the extent of the operation.

Having explained the physiological risks of radiations, the exhibition shows some of the means employed for the protection of workers exposed to radioactive substances, ranging from a model of the instrument used in uranium-mines to detect radon gas, to the strips of film and "fountain-pen" monitors worn by the staff of industrial and research establishments.

The Palais de la Découverte has, of course, drawn greatly on the French atomic energy authority for assistance in the preparation of the exhibition, and a large part of the exhibits are French, though as much material as possible has been obtained from abroad. Apart from the American, British, Canadian, and Russian reactor models, radioactive ore from the U.S.S.R. is to be seen in the geological prospection section, photographs from Canada and Great Britain show the use of the cobalt bomb in the treatment of cancer, and there is a protective suit from the U.S.A. So the visitor is constantly reminded that this fast-developing field is one which, like so many others, depends for progress on discoveries made in many different countries.

John Sheldon.
(Specially drawn for DISCOVERY *by Horrabin)*

JOHN SHELDON (1752–1808)

Anatomy, ballooning, whaling—such diverse pursuits engaged the attention of a remarkable man who died 150 years ago. The son of an apothecary, John Sheldon was born in Tottenham Court Road, London, in 1752. He was educated at Harrow and studied anatomy in Henry Watson's private museum in Tottenham Court Road. Watson was later elected first Professor of Anatomy to the Surgeons' Company. Having obtained his diploma from this Company on November 2, 1775, Sheldon lectured at the famous school of anatomy in Great Windmill Street under William Hunter. From 1777 to 1788 he taught in a private anatomy theatre which he had opened in Great Queen Street. In 1782 he succeeded William Hunter as Professor of Anatomy at the Royal Academy, and in 1786 he became surgeon to the Westminster Hospital, but had to resign two years later because of illness, when he moved to Exeter. In 1797 he was appointed surgeon to the Devon and Exeter Hospital.

All his life Sheldon was interested in the lymphatic system. But for the handicap of indifferent health (he died at the comparatively early age of fifty-six) his contributions to the subject might well have brought him greater fame. His book "The History of the Absorbent System", of which the first part only was published, in 1784—the year of his election to the Royal Society—was a model of its kind. He also edited the works of the German anatomist, Johann Nathanael Lieberkühn, under the title "Dissertationes Quatuor" (1782).

Among the many interests of this versatile man was the art of embalming, though not entirely for academic reasons. In his "Voyage en Angleterre et en Ecosse" (1797), the French *savant* Faiyas St Fond gives a graphic account of his visit to Sheldon about the year 1790. He was much impressed by the anatomist's collections and particularly intrigued by a sort of mummy kept near his bed. On opening a case with a hinged top, there was disclosed an inner case of cedar-wood containing the nude body of a 20-year-old girl with beautiful brown hair. Sheldon took great pride in drawing his visitor's attention to the suppleness of the arms, breasts, and cheeks, and carefully

described to him how his mistress, whom he had picked up in Oxford Street and who had later died of consumption, had been preserved with repeated injections of camphor dissolved in spirit. St Fond thought his host's ability to make an anatomical demonstration of one whom he had loved somewhat unnatural. When Sheldon married, his wife turned his mistress out of the house, and for many years she was stowed away in a back room of the museum of the Royal College of Surgeons until she was destroyed in a German air-raid during the last war.

Sheldon possessed an adventurous spirit to match his inquiring mind, for when he invented a poisoned harpoon with which to catch whales, he went on a voyage to Greenland to put this weapon to the test.

To Sheldon also belongs the honour of being the first Englishman to realise the age-old ambition of man to raise himself into the sky on self-made wings: when Jean Pierre Blanchard made his second balloon ascent from Chelsea on October 16, 1784, Sheldon was his passenger. This exploit, which was the subject of a caricature by Paul Sandby, is vividly described by Sir D'Arcy Power in his paper "The Centenary of the Royal College of Surgeons of England, 1900". When at one stage the balloon began unexpectedly to descend, Blanchard urged Sheldon to dismount in order to lighten the load: "If you are my friend, you will alight. My fame, my all, depends on my success." His passenger remaining obstinate, Blanchard swore he would starve him, and threw all their provisions overboard, with the result that the balloon promptly ascended. "It was a good French notion", writes Power, "that the best way to get rid of an Englishman was to throw out the eatables." By a strange coincidence, the first Scotsman to navigate the air in a balloon, at Edinburgh two months earlier, on August 27, 1784, was another surgeon, James Tytler, popularly known as "Balloon Tytler".

John Sheldon was buried at Combe Raleigh, Honiton. A tablet put up in the church by his widow records his "profound skill" in practice, his general knowledge, and the "simple elegance of manners, and dignity of deportment united in a benevolent heart", which "endeared him to man, as closely as unaffected piety commended him to God".

BLACK KNIGHT

Great Britain nosed her own way into space for the first time at 9 a.m. (B.S.T.) on September 7 from Woomera rocket range. The new *Black Knight* liquid-fuel research rocket was the champion of this foray, on the first occasion it has taken the air.

The event was generally hailed as "another breaching of outer space". This terminology is misleading for, of course, the rocket did not reach outer space, or anything like it. The only man-made tools to have penetrated any distance at all into outer space are the telescopes of astronomers and radio-astronomers, and this is likely to remain true for many, many years to come. The highest flying artificial earth satellite has so far merely touched the fringes of inner, or cis-lunar, space.

Nevertheless, *Black Knight* has done extremely well. It climbed a most respectable distance above the atmosphere and ionosphere and upon its first flight test. It rose to just on 300 miles in a vertical launching from Woomera, but a little late for the rocket to be put on public view at the Farnborough Air Show which closed the same day. It is a matter of special congratulation to the designers and the construction team that the rocket "performed perfectly" upon its first test firing. What comparable large rocket can boast such a record? *Black Knight* has been developed within 2½ years, according to Mr Aubrey Jones, Minister of Supply. The cost of this, which covers the building of some two dozen *Black Knights,* has been between 4 and 5 million pounds—a tenth of the amount originally suggested by Australian sources. "We do somehow or other manage to do things on a shoestring," said the Minister modestly, when discussing *Black Knight*'s budget at his special press conference.

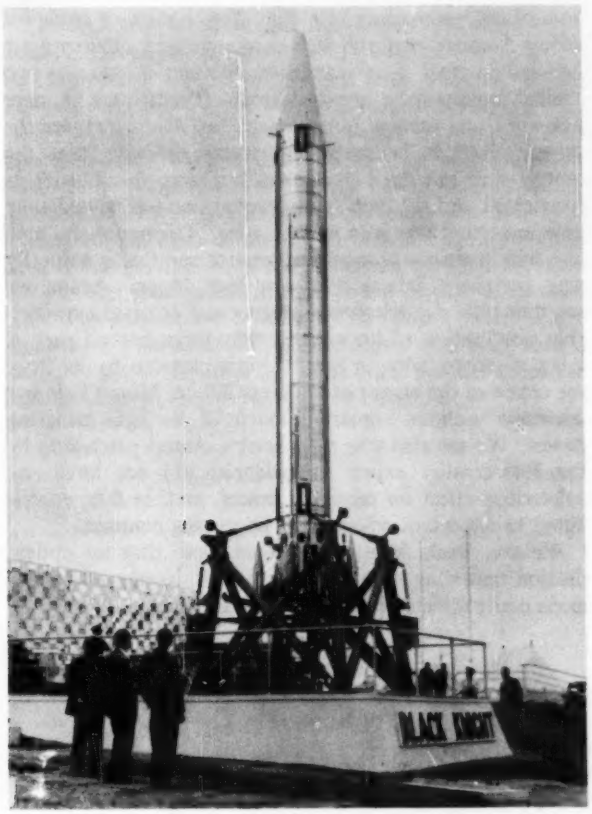
The rocket's design, characterised by its strength and simplicity, has been the responsibility of a team working under the general direction of Mr E. C. Cornford of the Royal Aircraft Establishment, Farnborough. The rockets are being built on the Isle of Wight by Saunders-Roe, Ltd, who also carried out a considerable amount of the development work. Armstrong Siddeley Motors of Coventry developed the rocket engine from an original design prepared by the Rocket Propulsion Department of RAE, at Westcott.

Black Knight is designed for research on the re-entry of bodies through the Earth's atmosphere—research which is of principal interest to the military for whom it is expected to engender a family of intermediate or even longer range rocket weapons. For, at present, it is bombs not people that the defence chiefs wish to send on long fast journeys, and it is they alone who can afford large rockets.

Nonetheless, *Black Knight*'s performance does place an earth satellite or other space research programme within the grasp of British scientists, as the Minister of Supply has been the first to point out. The single-stage *Black Knight* on its own (with a maximum speed of 9000 m.p.h. and altitude in the 300-mile class) is not a potential satellite-launcher. But a solid-fuel boost-rocket is currently under development as a similar joint RAE-Saunders-Roe project to perform as second and third stages of a *Black Knight* step-rocket combination. With two stages the vertical range is expected to be about 600 miles; with three stages the range should go up to 1500 miles and makes the launching of a small satellite on American lines possible. By this is meant an object with a payload of pounds rather than hundredweights (as the *Sputniks* are).

The value of launching such vehicles is at present under consideration along with other suggestions for a British space programme by a special committee of the Royal Society under the chairmanship of Prof. H. S. W. Massey, F.R.S. British scientists have been very fruitful with ideas for upper atmosphere research in the past but have been in the galling position of having neither rocket nor satellite as a vehicle in which to conduct their experiments. So it is quite possible that small British satellites could make a useful and individual contribution to space research. At the same time there is a strong sense that unless something specially attractive is in view for such small-scale satellite experiments (and the first British satellite cannot possibly be expected up before the latter part of next year), it might be better to wait a little longer for something more distinctive. For instance, Britain might be better advised

to concentrate her limited resources on raising a research rocket extremely high (of the order of say 20,000 miles up) rather than on putting one into orbit. It is understood this is also under consideration by the Royal Society's advisers.



Britain's *Black Knight* Research Rocket.

BORON PROMOTED

Just 150 years after the first liberation of the element boron by Gay-Lussac and Thénard and then independently by Davy, boron has leapt to prominence in high-energy fuels for guided missiles, fuels costing such a price as to be dubbed "exotic" or even "quixotic". This sudden change in boron history is more remarkable than the rise of titanium, for example, since boron has been known for so long, as an element as well as in borax and boric acid.

Gay-Lussac and Thénard in 1808 described before the Institut the reduction of boric acid by metallic potassium in a copper tube. They separated the insoluble amorphous boron from the residue, and noted how very reactive it was in oxidising vigorously—almost a prediction of things to come. Davy first stumbled on boron in an electrolytic experiment. He, too, used his own potassium—so recently discovered—in preparing boron and described it before the Royal Society also in 1808.

For decades to come boron chemistry outside laboratory walls centred on boric acid and the borax of pharmacy. There was no more excitement in the story than the harnessing with steel casings of the powerful *soffioni* or volcanic steam jets. By drilling new fumaroles, Italian engineers of the Società Boracifera not only kept awake the inhabitants of Lardarello with the roaring jets, but won boric acid and other chemicals from the condensates. This association of vast sources of natural energy with mild boric acid or boron was commented on at the time with some wonder; yet in Count Conti's time any suggestion that one day man would visualise the production of hydroborons as sources of energy would have been deemed "quixotic" to say the least. Boron and carbon are near neighbours in the chemist's classification; yet in Nature vast quantities of hydrocarbons only were fortunately provided, with hydroborons ever rare laboratory curiosities.

Since the free element has found some applications, these may be outlined on this anniversary of the element. Boron has gone into semi-conductors, into lightweight neutron shields for reactors with aluminium or plastic as foundation. The element is alloyed with aluminium to improve electrical conductivity, while hard materials resisting high temperatures come from borides of tungsten, titanium, and tantalum. Not so long ago the metallurgist had little use for boron apart from small inclusions for increasing hardness in medium- and high-carbon steels. But then came the use in control-rods for reactors, at first only 2% in the steel, but now up to 5% in cast tubes or 3·8% in extruded tubes as at Calder Hall. Boron had but small military significance in delay fuses, flares, igniters, and propellent mixtures before the advent of high-energy fuels.

Hydroborons, when first prepared in the laboratory, were difficult to make and to handle. By the action of dilute acid on magnesium boride, a mixture of such hydrides as B_4H_{10}, B_5H_9, and B_6H_{10} was obtained. Of these the pentaborane is stable and has won favour among high-energy fuels, this hydride being produced when gaseous B_2H_6 loses hydrogen and forms higher boranes. The idea of using such out-of-the-way compounds came from a study which showed that high heats of combustion were given by the lighter elements, or their hydrides. Since liquid hydrogen is not practical, beryllium very toxic, and lithium hydride at that time rather rare, boron hydrides or boron alkyls were obvious choices—if only their high costs could be reduced.

In 1947, boron compounds as ram-jet fuels began to attract full attention, an intensive American project of 1952 being appropriately named ZIP. Difficulties of producing pentaborane and decaborane were studied, the preparation of B_2H_6 on a laboratory scale was improved by the reaction of lithium hydride on boron fluoride etherate; sodium hydride and borohydride were also tried in place of the lithium hydride. The latter thus came to some use after all. In jet engines, incorporation of boron alkyls or organic derivatives also received considerable attention because these alkyls were less toxic than boron hydrides. But difficulties remain to be overcome, one of these which applies to all boron fuels, is the formation of boric oxide films in engine units. Pentaboron is the favourite with a heat of combustion of 31,100 B.Th.U. per pound; a high figure, yet the price of this fuel is equally high: $2100 a gallon as produced in the pilot plants of today and maybe $700 in large-scale production in 1959. After 150 years that insignificant element of Gay-Lussac, Thénard, and Davy has certainly begun a new chapter in its history, a chapter with a difference!

OPTICAL ILLUSIONS AND SCIENTIFIC OBSERVATIONS

S. TOLANSKY, D.Sc., F.R.S.

Professor of Physics, Royal Holloway College, London University, Englefield Green, Surrey

The history of the practical exploitation of optical illusions stretches from the present-day conjuror's tricks back to and beyond the days when the ancient Greeks used convexity to correct the illusion of concavity in straight tall columns. There are many fallacies of vision which may be explained as optical fatigue effects, such as after-image illusions, and complementary colour illusions, and, of course, the persistence of vision often plays an important part in illusions. Much has been written in connexion with these effects, for example concerning the cinema.

The general purpose of this article is to arouse interest in a few of the simpler geometrical illusions, familiar to many. Further, the author would particularly like to emphasise what is not usually recognised: these psychovisual errors in judgment can seriously influence scientific assessments of quantity. The danger with such effects is the failure to recognise that they may exist. Once aware of their occurrence, however, one is not easily fooled. This is the real justification for the writing of this article.

AN AREA ILLUSION

Let us take as a first example the widespread failure to recognise *at sight* the relative contributions to the total area of the outer zones of a disc. Fig. 1 shows a circle (of radius 5 units), and although even practised observers are inclined to treat it as incredible, the fact is that the two shaded regions have identical areas. (Proof: area of inner disc $=3^2\pi$ and area of outer ring $=5^2\pi-4^2\pi$, which are the same.) Almost invariably observers estimate that the central disc has the bigger area, but once this illusion is recognised and the true fact accepted, we see immediately how important this is in lens practice. The peripheral area of a lens is clearly of most importance and this is naturally why periphery defects domineer lens design. Again, we see now why the telescope-designer can tolerate considerable obscuration of an unexpectedly large central part of a big telescope, why, in fact, so big a part can be cut from the centre of the mirror of the great 200-in. Mount Palomar telescope without impairing much of its light-gathering power. We see also why the use of a central patch-stop by the 19th-century expert microscopist did not have any deleterious effect on resolving power, and, in fact, contributed to important advances in improving contrast.

We see, then, from our first example that an optical illusion regarding relative areas tends to confound phenomena easily demonstrable by simple arithmetic.

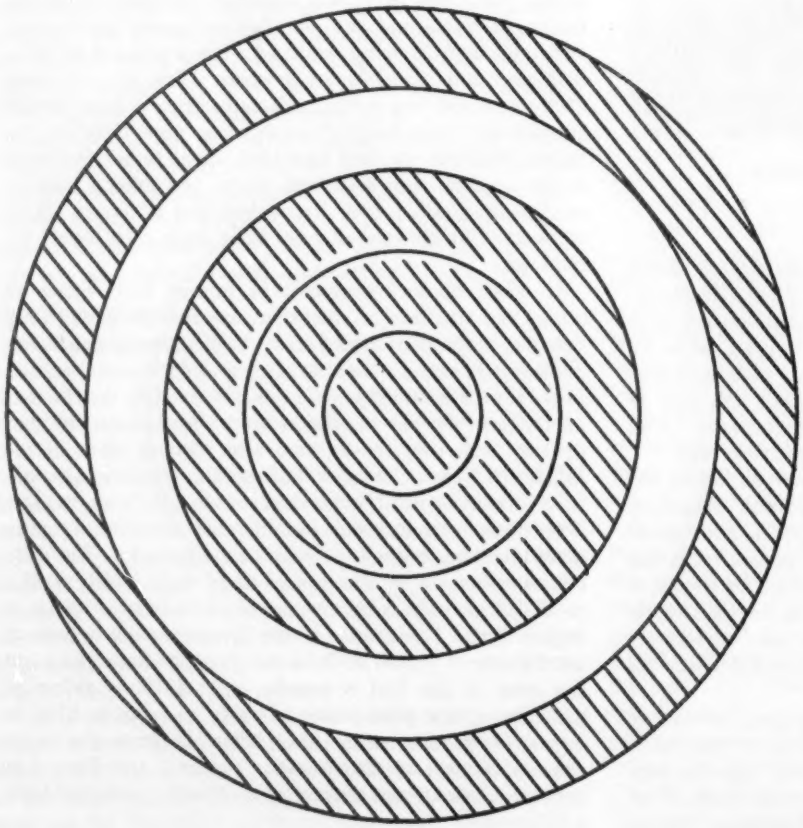


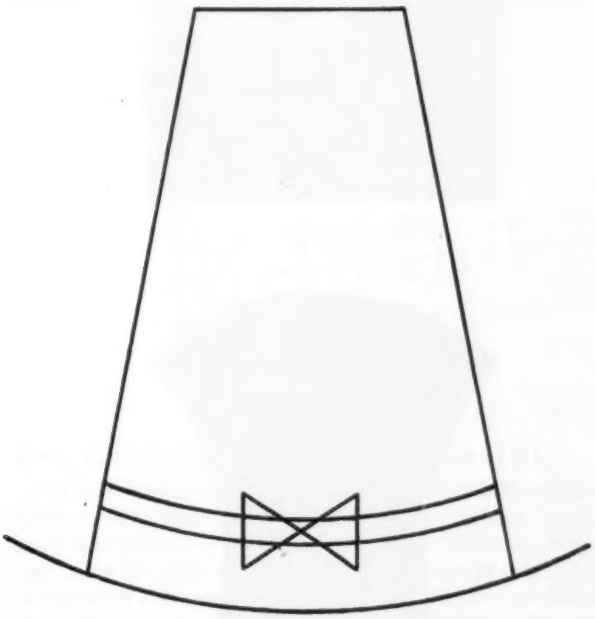
FIG. 1.

FALSE WIDTH

Consider a second optical illusion. The author has yet to find the observer who straight away accepts his statement that the Quaker's hat in Fig. 2 is *exactly as wide as it is tall*. It is. The doubter is advised to make a measurement.

In this example of illusion we underestimate the *width* because the object is long and tall with, so to speak, an inconspicuous "wing", which is the brim. Now the author has been trapped by this very same error more than once when attempting a visual estimate of the width of a spectrum line. Such a line is also long and thin with shaded-off "wings", and the writer has invariably underestimated the width. Indeed, nearly every spectroscopist will agree that he is constantly surprised at the true width of a spectrum line when it is recorded by a microphotometer. The false width illusion is not nearly so effective when one estimates the width of an interferometer fringe (such as a Fabry-Pérot fringe) because, as a rule, such a fringe is not a "tall thin line" but often broader than it is long and thus not subject at all to this illusion.

FIG. 2



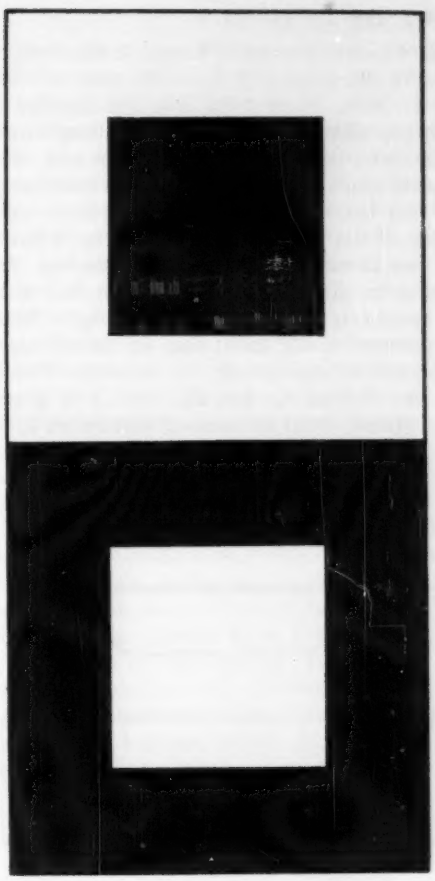


FIG. 3.

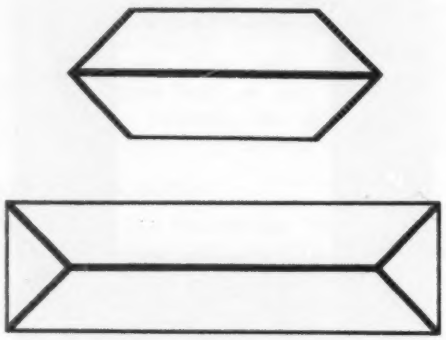
COMPARATIVE AREA ILLUSION

A well-known illusion which exerts a closely allied effect is illustrated by Fig. 3. Here we have a white square on a black background and beneath it a black square on a white background. The two inner squares are exactly the same size. Provided the page is brightly illuminated most observers will agree that the white square *looks* appreciably larger. The effect of irradiation, presumably on the retina, is such that the edges of the white regions appear to encroach into the black regions. The white inner square thus appears larger than it actually is, while the inner black square appears smaller than it is. This type of illusion is very commonplace, and yet to the author's knowledge it has not been recognised by spectroscopists that it can affect visual estimates of the widths of spectrum lines, and that it can do so in two unexpected ways. For the effect is operative not only if bright lines are under view but also in contrary directions for emission lines (bright lines on a dark background) and absorption lines (dark lines on a bright background). Of course such errors in estimation are purely visual defects and a microphotometer measurement would dispose of the illusion. Visual estimates of line-width by spectroscopists are notorious for their inaccuracy, still, the author has yet to find spectroscopists who have considered this optical illusion as one possible cause for discrepancies.

ERRORS OF LENGTH

A different class of error is known to arise when assessing visually the lengths of lines, the ends of which are bracketed. Most of us have seen the familiar illusion arising if one takes two lines of the same length and places *diverging* arrow-heads at the ends of one and *converging* arrow-heads at the ends of the other. On examining mixed crystals in a microscope the author has been confounded by effects of the following kind. In Fig. 4 two crystal shapes, one above the other, are seen end-on. Now the reader may be definitely assured that in *both* shapes the central horizontal edges are the same length. Yet even a critical observer would assert that the central edge of the upper crystal is undoubtedly the smaller. This illusion clearly also extends to irregular bodies in general and warns us against visual estimates of dimensions in irregular shapes.

FIG. 4.



IDENTICAL LENGTHS?

A very closely related but far more confusing optical illusion is created by a consideration of the diagonals of parallelograms. Fig. 5 was shown to a keen-eyed artist who, on being informed that the two strongly marked diagonals are of identical length, was incredulous until a ruler was produced to prove the assertion.

Now it may be thought that this is a little theatrical, yet the author, when studying the hardness of metallic crystals, has been tricked in a most surprising way by a closely related illusion. In these hardness tests a square-based diamond pyramid is forced into metal. If it is polycrystalline, it produces a square-shaped indent like the lower image in Fig. 6. To compute the hardness, one measures both the diagonals (they may differ slightly if the indenter does not enter quite perpendicularly to the surface). When an indent was made on a single crystal of tin, because of directional crystallographic hardness properties, the impression formed was not square but of the shape shown at the top of Fig. 6, with two opposite sides convex and two concave.

The surprise here is that in both figures the diagonal lines which can be drawn to opposite corners are of exactly the same length when measured, for indeed both figures were drawn from four points at the corners of squares of the same size. Even more startling is the fact that the diagonals in the upper pattern also *cross each other at right angles*, as they do in the lower. This hardly seems believable when judged by the naked eye. This example is really a salutary lesson on the danger of a quick visual assessment without measurement.

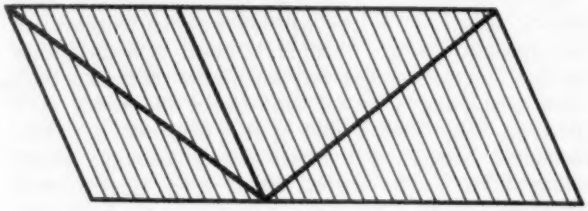


FIG. 5.

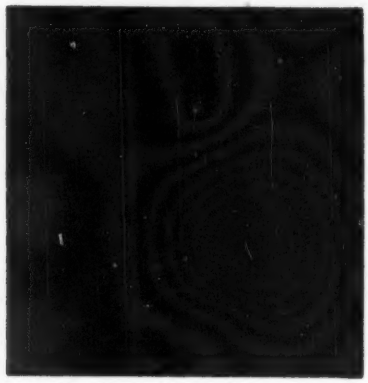


FIG. 6.

ERRORS OF PERSPECTIVE

Some disturbing optical illusions involve perspective, both in drawings and in actual viewing of distant objects. For instance, in a well-known type of drawing, an example of which is shown in Fig. 7, the three towers are exactly the same size. However, the one on the right appears gigantic compared to that on the left because the perspective drawing makes us expect the distant object to subtend a smaller angle.

Now it is well known that this optical illusion can completely explain why the Sun and Moon appear to be such huge balls when seen low on the horizon. We invariably feel sure that the angular diameters of the Sun or Moon have increased, yet it is easy to establish, by holding out a small coin at arm's length, that in fact the Moon (or Sun) subtends practically the same angle no matter whether it is high or low in the heavens (refractivity has a negligible effect on this). But when the Moon is low we instinctively expect it to subtend a smaller angle, as terrestrial objects do which are away off towards the horizon. As this does *not* happen, we immediately attribute gigantism to the Moon, exactly as we do to the tower on the horizon in Fig. 7. The key-point is, of course, that the Moon *does* subtend a constant angle, whether high or low in the horizon, while the terrestrial object subtends a smaller and smaller angle as it moves off to the horizon.

An optical illusion of this nature has often been met in the author's laboratory under closely related optical conditions. The Fabry-Pérot interferometer is an instrument which consists of a pair of silvered parallel discs of glass, say of 2 in. diameter. When suitable light is viewed through these, one sees interference rings which are in fact viewed at infinity. They subtend a constant angle to the eye, no matter how far away the plates are from the observer. This is exactly the same as what happens with the Moon, which also subtends a constant angle to the eye. Now the interferometer plates on the laboratory bench subtend their own particular angle to the eye of the observer, and on viewing, say at 1 m. distance, one usually sees a number of interference rings filling the aperture of the instrument discs.

If one now moves away from the instrument, because the angle subtended by the glass plates steadily diminishes, fewer and fewer rings fill the aperture; for the angular diameters of the rings remain constant. But as a result of this, one invariably gets the very vivid illusion that the rings are in fact getting bigger and bigger and soon the interferometer plates appear to be filled by one gigantic ring. This illusion is absolutely identical with the familiar "Moon illusion". Without exception, those for whom the author has made the demonstration declare that the rings are growing rapidly as the observer moves back. They are not, of course; the illusion arises purely from the maintained constancy of the angular diameter of rings at infinity. It is sometimes very difficult to convince critics of the significance and correctness of the explanation of the "Moon illusion", but they accept this at once when the interference-ring demonstration has been mounted.

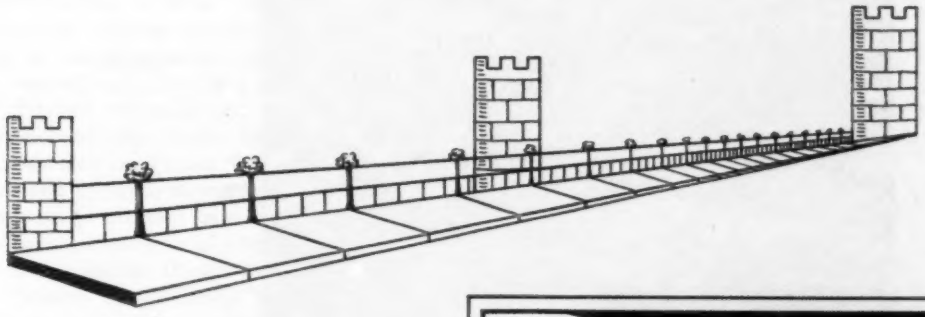


FIG. 7.

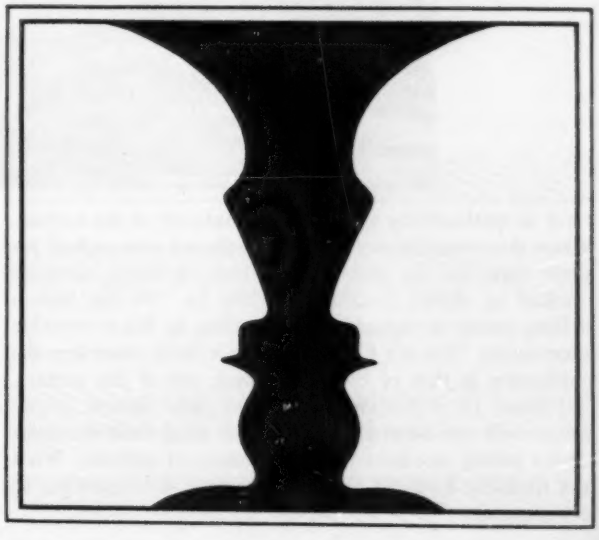


FIG. 8.

THE PHENOMENON OF OSCILLATION

We now come to the consideration of the well-known psycho-visual phenomenon of oscillation, a subject which has been studied for many years in other contexts. Here once more we meet an illusion which appears at first sight to be merely a drawing-room trick, but again this can affect scientific observation in an unexpected manner. Look at Fig. 8. To some this appears at first to be a black vase of some kind, to others the first impression obtained is that of two light profile faces, looking at each other. To most, it can oscillate from one to the other, the mechanism of oscillation involving a change-over from concentration on light regions to concentration on dark regions.

Some years ago the author noticed a very closely related illusion while looking at some photographs of etch effects on diamond surfaces, an illusion which leads to a visual

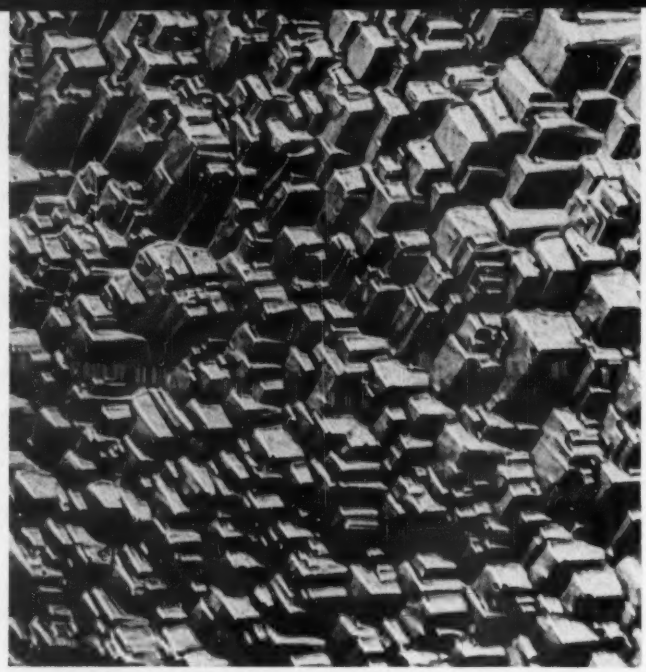


PLATE 1A.

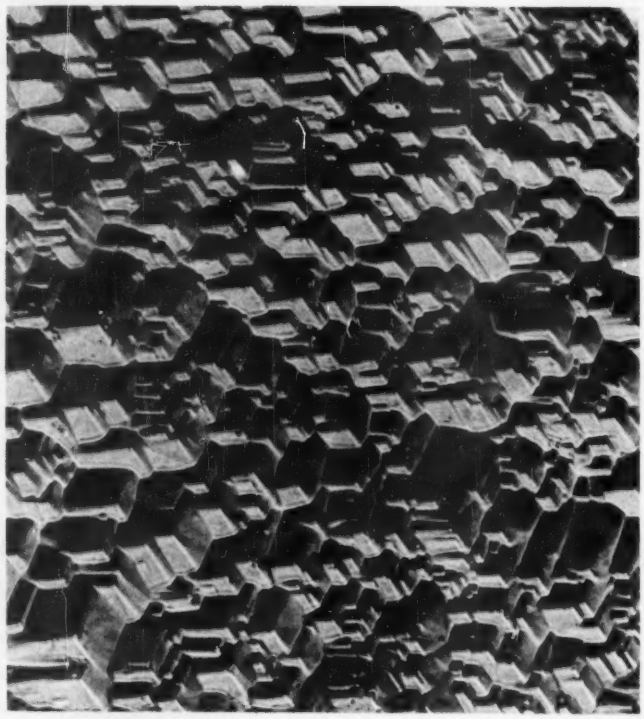


PLATE 1B.

error in qualitatively assessing the character of the surface. When the octahedron face of a diamond was etched for some time in hot potassium nitrate a micro-structure resulted as shown (×2000) in Plate 1A. We see here a striking group of rugged blocks standing up like a veritable microscopic "Giant's Causeway". For most observers the impression is that of blocks standing *out* of the picture. Yet Plate 1B is precisely the same plate *turned upside down*, with the surprising result that what were formerly blocks jutting out have become recesses or caverns. What was formerly assessed as an elevation is now assessed as a depression.

It seems fairly certain that this striking illusion is associated with the way in which we normally see shadows cast by the Sun, for these photographs were actually taken with an oblique illumination. We accordingly assess hills and hollows by their shadows and thus get a false interpretation according to whether or not the picture is upright or inverted. To add to the complication, some observers of these pictures are subject to oscillation, and see now one interpretation, now the other. It would seem, however, that most observers perceive Plate 1A as blocks and Plate 1B as caverns. The oscillation effect is undoubtedly closely related to the trick picture of Fig. 8.

DISTORTIONS IN SYMMETRY

This section may be concluded with reference to the oft-shown distortions in symmetry formed by cross hatchings. These are all well known, yet they too can affect experimental observations. Thus in Fig. 9 the true circle (A), the true square (B), and the truly parallel lines (C) all appear to be badly distorted because of the superimposed cross hatchings. Indeed, the writer has found on many occasions that such apparent distortions can arise in studying the micro-structures of crystals. It is by no means unusual for growth patterns to be crossed by hatchings. These hatchings may be natural growth striations, they may be regular parallel arrays of slip bands crossing growth patterns, or they may well be interferometric contour lines superimposed upon a microtopography for measurement purposes, lying in regular arrays across growth features. These parallel lines can and do act in precisely the same way as those shown in Fig. 9 and thereby can cause confusion if one is not aware of their effect. In testing the effect of such patterns the author finds that the degree of astigmatism present in the eye and the extent of its correction can affect the vividness of the illusion presented by cross hatchings. Thus it is likely that the response to Fig. 9 will vary with different readers.

SPACE-TIME ILLUSIONS

A very extensive class of illusions can, of course, be created the moment optical instrumentation of one form or another intervenes between the object and the observer. These can range from the crude and simple, such as the historical Pepper's Ghost, to those more sophisticated parlour guessing-games based on anomalous foreshortened camera close-ups of domestic articles photographed from unusual angles. Among such illusions is a complete group which can be classified as space-time illusions. These include normal stroboscopic effects, anomalous stroboscopic effects often seen on cinema and television, and many illusions created by rapid movement of the head and eyes. Two such illusions affecting respectively an apparent increase and an apparent decrease in velocity have already been described in this journal (DISCOVERY, 1958, vol. 19, No. 9, p. 397, "Science on the Screen"). Such illusions, while clearly able to vitiate unwary scientific observations, are sufficiently different in character from those described here to merit a separate discussion.

CONCLUSIONS

It is hoped that this brief survey has established that many of the well-known innocent-looking optical illusions can indeed become serious pitfalls in qualitative scientific observation. It is once more emphasised that all of these errors are immediately resolved when exact measurement is made, but it must surely be agreed that a vast amount of scientific information is secured qualitatively as well as quantitatively. It is when making purely qualitative and non-exact observations that scientists can be misled by illusions.

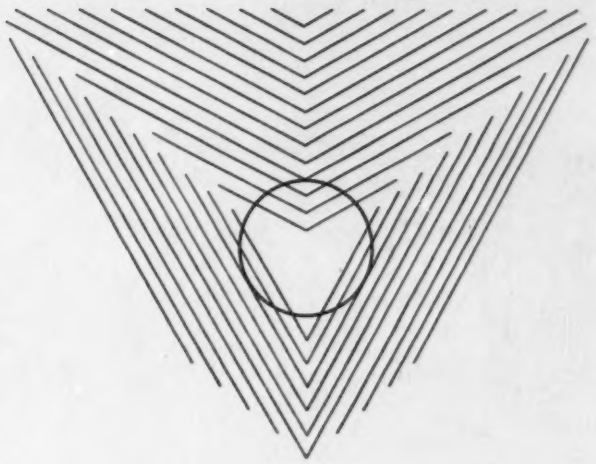


FIG. 9A.

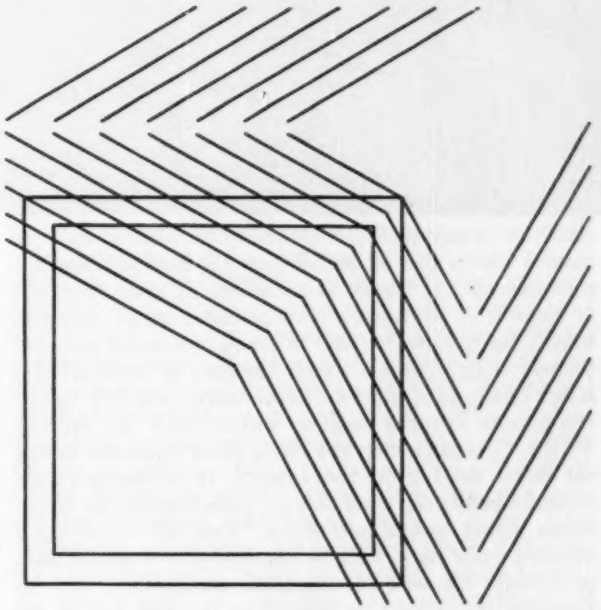
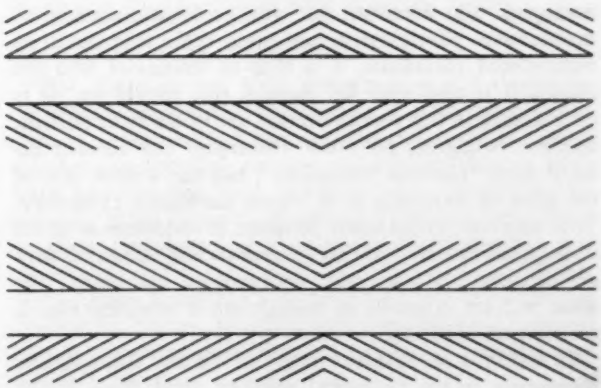


FIG. 9B.

FIG. 9C.



THE MODERN NATURALIST

E. M. NICHOLSON

FIG. 1. A view of Cripplegate, London, showing vegetation that has flourished in the devastated areas.
(Photograph by C. B. Ashby)

Although observations and reflections on what we now call natural history can be traced from the earliest times, the conscious idea of Nature as something set apart from and in contrast to civilisation (and moreover as an attractive subject for observation and hence of systematic and continuous study) seems to have emerged in modern form rather late in the European Renaissance. The first readily recognisable natural history writers such as William Turner, Conrad Gesner, and Pierre Belon flourished during the middle third of the 16th century. It was another three centuries before the word biology, coined during the Napoleonic period, gained acceptance. Even as recently as a hundred years back, Charles Darwin, now a patron saint of biology, followed his illustrious predecessors such as Linnaeus by introducing himself in the first line of the "Origin of Species" as a naturalist.

THE NATURALIST HIMSELF

Now that the field is thronged not only with biologists, zoologists, and botanists, but with ecologists, ethologists, taxonomists, physiologists, and many other secessionist or rechristened naturalists, it is time to reconsider who the naturalist is and what his modern role should be. It is encouraging in this connexion that one of the most brilliant modern biologists, Dr Niko Tinbergen, has entitled his latest book "Curious Naturalists", and has written in it of his hope of recruiting more young naturalists to biology. This, however, might easily be taken as endorsement of the widespread assumption that naturalists and natural history are necessarily less scientific than biology, and indeed that what is truly scientific is biology while anything else is merely natural history.

In fact it is notable how many of the key concepts and discoveries in the biological sciences, right down to the present day, have come from men who were never formally trained or who never earned their living as biologists. Schoolmasters, doctors, clergymen, explorers, and even company directors and administrators have made impressive contributions. Naturalists are by no means necessarily untrained amateurs, but relatively few paid biological posts include practising as a naturalist among their main duties. Plenty of naturalists who are professional scientists do most or all of their natural history as a spare-time activity, and thus form a valuable bridge between the two worlds. Nevertheless the number of trained biologists employed mainly or entirely as naturalists on field studies is, although still small in Great Britain, rapidly increasing, following a trend visible earlier in North America and elsewhere. While this is both inevitable and desirable, it does increase the danger that the amateur or part-timer may be looked down upon and discouraged, at any rate implicitly, by the professional whole-timer, and steady vigilance will be needed to ensure that such a narrowing and short-sighted tendency is not allowed to develop.

HIS QUALIFICATIONS

It is, of course, true that the amateur naturalist has obvious weaknesses and limitations. He is often quite untrained, and very rarely fully trained in the relevant problems and techniques. He may aggravate this handicap by a lack of interest in what biology has to teach him, and he is likely to be short of time to read fully the scientific literature and often also of opportunity to get access to it. He is rarely well placed to define his subject of investigation at the outset or to design and execute the best series of experiments or observations to lead him to a solution through successive clearly appreciated stages of research. He may even lack basic equipment and ability to work to

precise standards of measurement and recording. He tends to be biased towards observing the rare or peculiar rather than the normal and common situation. He tends also to find difficulty in weaning himself from an "anecdotal" or subjective approach.

These are formidable weaknesses, which could well be crippling if they were not being consciously corrected and if they were not also compensated by great sources of strength. Among these are the patience, concentration and resourcefulness which naturalists share with anglers and hunters, and a keenness not only for pursuit and observation but for comparison and reflection, leading to an awareness of Nature as a living whole and some understanding of the animals and plants in their living environment. The need for knowing where to find each species and how to recognise it, often in unfavourable conditions, and still more the effort to understand the significance of behaviour, is a type of challenge which can give rise to extraordinary skills and achievements. It also, unfortunately, tends to make a gulf between the professional based in a laboratory or museum and the field naturalist. The latter finds it difficult to get on to common ground with anyone so wholly incompetent and uninterested, when it comes to using his eyes and ears to tell him what is in the field, as, unfortunately, too many excellent professional biologists now are. Such professionals have often sincerely felt that living creatures roaming or growing at large are unsuitable subjects for truly scientific studies, which must await their arrival as specimens for treatment in the laboratory or museum. Recent trends in the study of evolutionary biology have, however, destroyed the last vestiges for justification of this attitude. It is now not seriously disputed that understanding of biology ultimately depends on knowledge of the living animals and plants in their natural environments. This plays the ball back to the naturalist, since even the best equipped and most lavishly supported professional teams cannot hope to match the army of amateur naturalists in capacity to cover so much ground and to find, identify, and watch so many species.

ORNITHOLOGY—A KEY SUBJECT

It is therefore becoming more and more widely recognised that the largely amateur naturalist and the normally professional biologist must take much more trouble towards mutual understanding and mutual support in what is essentially a complementary team relationship. The key to this relationship is fortunately no longer a problem; it has been found in ornithology, which during the past three decades has made spectacular progress towards a leading role in biology by following certain simple principles of organised teamwork which had long been known but were only systematically developed shortly before the Second World War.

I hope I may be forgiven for quoting here what I wrote in DISCOVERY (vol. 11, No. 10, pp. 330–2) as long ago as October 1930:

> "The problem of reducing this inefficiency, of making ornithology more scientifically fruitful, deserves precedence. . . . This central problem resolves itself into a question of organisation, for the mass of observers capable of useful work who are not at present doing any can only be harnessed to a definite scheme . . . the ordinary observer . . . has neither scientific training nor the opportunities to keep abreast of his subject, and no one is more ready to recognise how much he might benefit from expert direction within suitable limits. . . . The success of bird-marking proves the spirit of co-operation waiting to be harnessed by leaders commanding the confidence of numbers of observers . . . the long, leisurely collecting and arranging stage in ornithology . . . can do nothing further of importance without merely repeating itself. In order to remedy this shortcoming it is necessary for the specialists to take active steps in directing the energies of all bird-watchers to the most fruitful problems, and the growing complexity of these problems demands some closer relationship than that of a group of isolated workers in the same field."

The diagnosis outlined above represented the considered views of leading British ornithologists at that time, and they joined together to put these views into effect, primarily through the foundation of the British Trust for Ornithology and the Edward Grey Institute of Field Ornithology at Oxford, which have been supplemented by several other important new bodies such as the Wildfowl Trust and the network of bird observatories, and locally by an impressive number of county and other bird clubs, ornithological societies or ornithological sections of natural history societies or naturalists' unions, often publishing excellent annual reports. It would be impossible here even to outline the elaborate structure and co-ordination of local, regional, national, and international teamwork, in whose development Great Britain has taken a leading part. Similarly the many achievements made in advancing knowledge of bird migration, population, distribution, breeding biology and much else, and in recruiting and training very large numbers of new ornithologists through a vigorous and widely decentralised organisation. While similar patterns have been created independently and with comparable success in certain other sciences, notably archaeology, several branches of natural history where they were quite as urgently needed were not so quick in acting. One unfortunate, unintended, and unforeseen result of this has been that birds have "stolen the picture", largely because the great harvest of interesting and exciting results of ornithological teamwork has enabled birds to gain the lion's share of broadcasting, television, and press publicity while the highly organised bird-watching movement has attracted and retained a correspondingly large proportion of the new recruits to an interest in natural history.

THE COUNCIL FOR NATURE

This distortion has been embarrassing and should be consciously corrected in the interests of a healthy development of British natural history. The right way to correct it is for corresponding development to take place in other lines, and this has been initiated most successfully, for example, in the Botanical Society of the British Isles' Atlas of Plant Distribution and through the foundation and vigorous growth of the Mammal Society and most recently of the British Trust for Entomology and the comprehensive Council for Nature, to which well over a hundred natural history societies, including most of the largest, have already adhered.

FIG. 2. (*Left*) These starlings are caught by nets from the ledges of buildings around Trafalgar Square and are then transferred to a sack. They are then ringed and plumage details are taken.

FIG. 3. (*Centre*) The details of plumage are recorded and the bill is sketched. The colour gives an indication of the age and sex of the bird.

(*Figs. 2 and 3 were photographed by Eric Hosking, F.R.P.S.*)

The Council for Nature brings together mainly professional bodies, such as the Institute of Biology, with bodies having definite missions such as the Council for Field Studies or the Society for the Promotion of Nature Reserves, and with national specialist bodies such as the British Trust for Ornithology and the Botanical Society of the British Isles, which include both amateurs and professionals. It is accordingly in a position to represent and serve the natural history and nature conservation movement as a whole in such matters as the provision of common services, the much-needed overhaul of education in biology and natural history teaching, and activity in public relations and the defence of places of importance to naturalists. Under the presidency of Lord Hurcomb and with Sir Landsborough Thomson, President of the Zoological Society of London as Chairman of its Council, it has first-class leadership, and the Duke of Edinburgh is its patron. It is accordingly to be hoped that a more balanced and stronger development of natural history as a whole in relation to biology may be achieved, although there can be no quick solution of such complex problems in view of the amount of inertia and complacency still to be overcome.

In addition to the national bodies, and no less significantly, the Council for Nature is strongly supported by regional and local natural history societies, naturalists' unions and county naturalists' trusts. The best of these are models of effective voluntary effort which can stand comparison with those in any other sphere, but the weakest are very feeble indeed and under pressure of rising costs and such rival attractions as Nature programmes on television, the problem of keeping them in existence is serious.

THE CENTENARY OF THE LONDON NATURAL HISTORY SOCIETY

What can be achieved by hard work and sound leadership is well demonstrated by the London Natural History Society, whose centenary is being celebrated this year, and will be marked by an exhibition, The Naturalists' London, at the Royal Exchange from November 3 to 15. The Society derives from the merger in 1913 of the City of London Entomological and Natural History Society (originally the Haggerstone Entomological Society) with the North London Natural History Society which had started nearly thirty years later, in 1886, as a schoolboy club. It is interesting to recall that the first of these bodies was almost solely interested in butterflies and moths until the 1890's, when it developed subsidiary interests in ornithology and botany, and that its membership, which had begun at twenty in 1858 never seems to have exceeded eighty. The North London Society by contrast was always interested in most branches of natural history and even half a century ago had set up "Research Committees" for botany, biology, Lepidoptera, and protection. Its membership grew from about 100 fifty years ago to over 200 in 1912. For a short time at this period it managed a bird sanctuary. It was only fifty years ago that ornithology (which now claims over a thousand out of the London Natural History Society's total membership of 1550) became significant enough to merit the addition of a fifth "Research Committee" to itself.

Nearly all the activities of the London Natural History Society are decentralised in self-governing sections covering Archaeology, Botany (with 450 members), Ecology (350), Entomology (290), Geology, Ornithology, and Ramblers, while there are also two vigorous outlying groups within the 20-mile radius from St Paul's bounding the Society's activities. The productivity of this amateur effort is notable. The very thorough Ecological

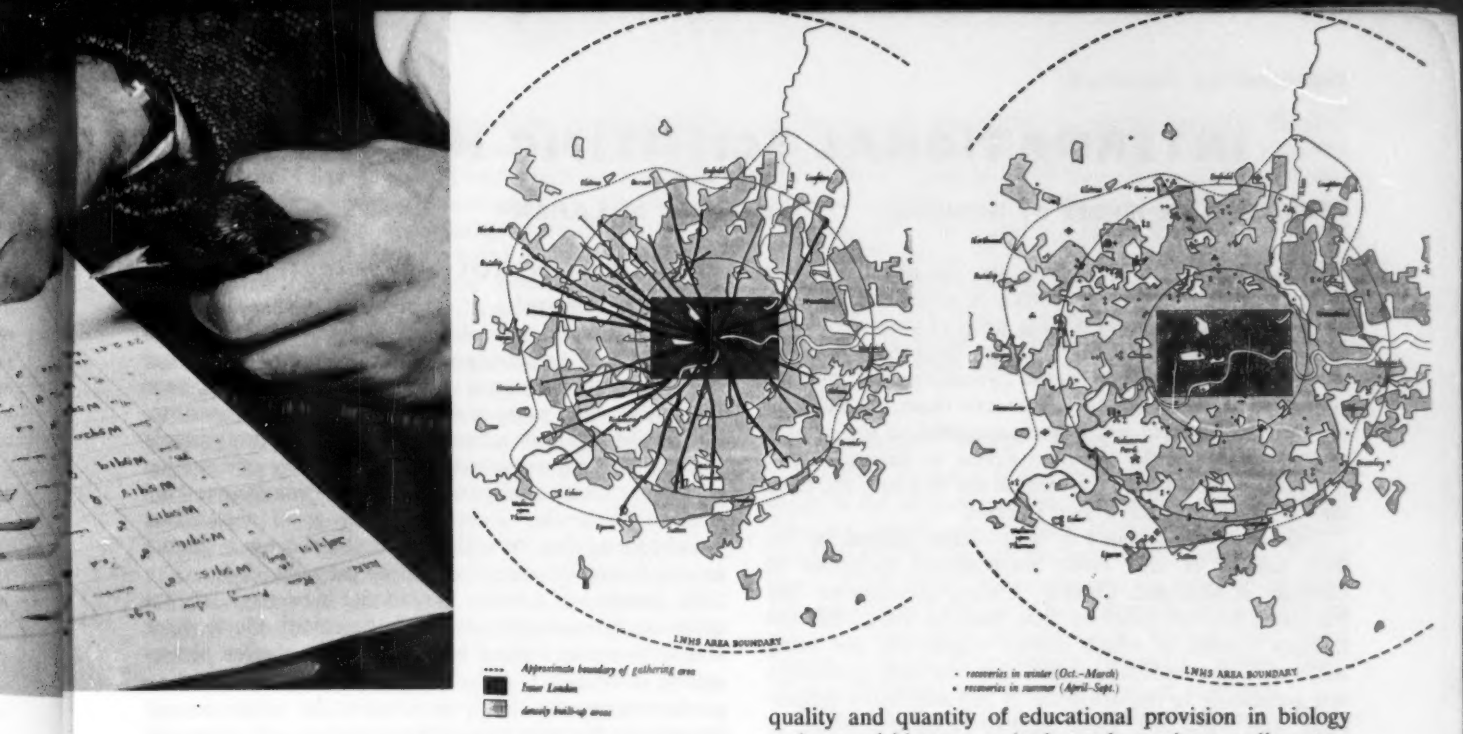


FIG. 4. (*Right*) Starling flylines to the central London roosts.

FIG. 5. (*Extreme right*) Recoveries of starlings from the central London roosts.

(These photographs are reproduced from "Birds in the London Area since 1900", London, Collins, 1957)

Survey of Bookham Common, now in its sixteenth year, has yielded scientific papers aggregating over 300 pages and has made this one of the best explored areas in England. The Ornithological Section's volume on Birds of the London Area is one of the best local ornithological handbooks available anywhere. The Surveys of City Bombed Sites have made a notable contribution to natural history, and it is impossible even to mention many of the scholarly and thorough lists and surveys in other branches of the subject. It is indeed probable that the total effort and output of the Society is now very near the upper limit which can be reached entirely by voluntary effort without any paid assistance. It seems that the obvious difficulties and limitations of metropolitan natural history have challenged the initiative and drawn out the full resourcefulness of the Society's membership. Nevertheless, there are several other bodies up and down the country which could also show an impressive record of good and varied work. It is the combination of these regional or local bodies in day-to-day personal contact with the more specialised but dispersed national bodies which provides so strong a stimulus and so valuable a service and backing to the British field naturalist.

THE FUTURE

While congratulating ourselves on much healthy progress we must not forget that in some important respects Britain is not an advanced but a backward country. Looked at as a whole our school population is grossly deprived of the quality and quantity of educational provision in biology and natural history required merely to give a rudimentary background about the earth and its resources, and to exploit the simplest of the purely educational potentialities in which natural history is so rich. Despite, and even because of, the stream of armchair entertainment about natural history provided by television and broadcasting, the minority who go out in the field determined to find their way about Nature is still alarmingly small compared with the merely passive audience. As ornithology and archaeology have shown, there are many whose eagerness and capacity to help in research is frustrated and left to waste until the right type of leadership and organisation comes along. Every day irreparable damage is being done to Nature and to natural history interests for lack of vigorous and alert support in a spirit of good citizenship by the many who care for these things, but evidently not enough to do anything practical to help, even to the extent of joining the nearest suitable society. Out of probably well over 7 millions positively interested in natural history, fewer than 150,000 belong to a natural history body of any kind.

Naturalists, with biologists, can contribute far more to science and civilisation than they have yet done. If they are to do so, they must be organised and equipped to work together as a team without sacrificing their individuality and variety of approach and the amateur spirit which is so valuable if linked with professional standards. The vicious circle of not enough resources, not enough active workers, not enough investigations, not enough opportunities and attraction for recruits, not enough influence and capacity to secure adequate recognition in education, land-use planning and in public affairs, and consequently not enough resources, can and must be broken through, not only in Great Britain but everywhere. Under the International Union for Conservation of Nature and National Resources, which has just been meeting at Athens, a good start is being made, but progress is still far too slow. If we are to enjoy a healthy balance in our civilisation this is one of the points which most needs and deserves extra support.

INTERNATIONAL SCIENTIFIC MEETINGS

Montreal: Congress of Genetics

Dr ANNE McLAREN Royal Veterinary College, (London University)

Genetics has a habit of getting into the news. For one thing, more than any other branch of science, it has been the arena for a seemingly endless series of spectacular professional quarrels, from the Bateson-Pearson row in the early years of the century to the Lysenko scandal and the resulting East-West schism of modern times. In addition the study of heredity has recently acquired an urgent note of topicality from the radiation danger to unborn human generations arising from the medical use of X-rays and from nuclear tests and atomic power stations.

This note was sounded in a resolution passed by the final session of the Tenth International Congress of Genetics in Montreal, Canada. Calling attention to "the increasing level of radiation from medical, industrial, and military sources to which human populations are being subjected", the resolution stated that "all such irradiation acts genetically to the detriment of this and future generations" and urged that "every attempt be made to reduce to a minimum these exposures and their ill-effects by action at the international, national, and individual levels".

MUTATIONS, GOOD OR BAD?

Sometimes the question is asked, "Is it necessarily a bad thing to increase the human mutation-rate? Perhaps some mutations are good for you, or, rather, for your descendants?" Work on fruit-flies, described at the Congress by the American geneticist Wallace, might, at first sight, appear to give colour to such an idea. Flies which were isogenic for one particular chromosome pair (that is, in theory, having one identical pair of chromosomes) were irradiated with X-rays. The first-generation offspring of such flies when mated with normal flies would all possess one irradiated and one normal chromosome. The offspring of the pair under study proved to be slightly more vigorous than those derived from two normal parents.

To a genetical audience there are two glaring differences from the human situation which make Wallace's experiment quite irrelevant to the problem of radiation hazards. The first is that he was concerned only with the first generation after irradiation, in which no individual could have more than a single dose of any given mutation caused by the radiation. In *subsequent* generations many individuals would carry such mutations in double dose, having inherited one from each parent. Mutations which only have deleterious effects when present in double dose ("recessive" mutations) are commonly encountered.

The second difference is that Wallace's flies were far more inbred and hence "homozygous" than man. Homozygous animals tend anyway to be feeble creatures; the effect of radiation would remove some of the homozygosity and hence in this way counterbalance the damage done in other ways. To argue from this to the case of man, who is highly cross-bred and hence heterozygous, is a little like saying that because a blow on the head sometimes cures cases of lost memory, the method could be used to improve the memories of schoolchildren.

CAN WE CONTROL HEREDITY?

Another main point of interest on the mutation front was the striking possibility emerging at this Congress that man may eventually gain some measure of control over the mutation process. The traditional view has been that agents which cause mutation, whether X-rays, neutrons, ultra-violet light, or chemicals of various sorts, merely increase the frequencies with which all kinds of mutation occur, and have no selective tendency to promote one kind rather than another according to the agent used. This "randomness" has been thought to be the most characteristic feature of mutation. At the previous Congress in 1933, Demerec of America showed that in bacteria different chemicals produce different sorts of hereditary effects. Now Drs Fahmy and Fahmy have reported a similar phenomenon in fruit-flies, and claim that the type of mutation produced depends not only on the particular substance used but also on the stage of development of the cell when it is treated.

Even more startling in this respect are the results on silkworms presented to the Congress by the Japanese biologist Nagao. Two particular mutations were studied, one producing red eggs, the other white eggs, and each known to be due to a change at a different point on the same chromosome. Two derivatives of nitrogen mustard of very similar chemical structure were tested for mutagenic (mutation-causing) effect. One produced a high incidence of the red mutation and very few whites, while treatment with the other resulted in a preponderance of whites. Since both substances appeared to be acting at the same stage of development of the cell, the difference between their effects must reflect a specific relation between the chemical structure of the mutagen and that of a localised region of the chromosome.

It is an old dream that one might one day produce *directed* changes in the heredity of plants and animals—that is, changes not at random, but in a particular direction chosen by the experimenter. At the Montreal Congress the "randomness barrier" seems at last to have been breached, not only in micro-organisms (this had already been accomplished by the time of the previous Congress), but in higher plants and animals too. On the other hand the possibility of producing directed mutations *which are also beneficial* remains remote.

CRANK'S CORNER REPOPULATED

But another section of the Congress showed how a remote possibility may suddenly plant itself squarely on the map of science. The "inheritance of acquired characteristics" has in the past been relegated to the Crank's Corner of genetics. Darwin believed in it, but since his day few scientists, with the exception of the followers of the Russian, Lysenko, have had the temerity to assert that traits acquired by the organism during its lifetime can be in any way transmitted to its children. Evidence presented

at Montreal suggests that we must think again. Durrant, for example, from Aberystwyth, reported an experiment in which groups of flax plants had been subjected to different fertiliser treatments, with effects on growth which persisted for at least four generations independent of any further treatment. Sinoto of Japan reported grafting experiments on egg-plants similar to those on tomatoes made famous (or infamous, according to one's point of view) by Russian Lysenkoists such as Glushchenko, who also described his work at this Congress. Sinoto finds that characters can be "picked up" by a grafted plant from the host plant on to which it is grafted, and then transmitted through the seed to its descendants. Fortunately, allegations of fraud (which was the first startled reaction of Western geneticists to the early Russian claims of "graft hybridisation") were not heard at this session.

Unfortunately Glushchenko's paper on "graft hybridisation", together with a number of other Russian papers on plant-breeding, vanished into thin air, owing to their unusual style of presentation. An English version of the paper was read at enormous speed for about twelve of the allotted fifteen minutes by an interpreter. At this point a slight pause occurred as the interpreter became aware that she had only covered perhaps one-half or less of the typescript. Rapidly turning to the end of the paper she completed the course in a breathless sprint.

A notable exception was the Moscow poultry geneticist Kushner. He presented a clear and factual paper in English, making the astounding claim to have transferred hereditary qualities from one poultry breed to another by blood transfusion. He sustained heavy fire from a large and sceptical audience for a further twenty minutes, meeting his questioners with amiable good humour and a refreshing lack of dogmatism. Since his experiment was on a large scale and carefully controlled, and since no satisfactory alternative explanation was offered by the critics, we have to face the possibility that Kushner is right.

One somewhat fanciful implication of this was brought out in a Canadian television interview: "Do you believe, Dr Kushner, that a white person transfused with blood from a negro donor might hand on negro traits to his or her descendants?" His answer "We do not do experiments on humans in Russia" was less than satisfactory. It would have been more to the point to state his belief, for which he has a certain amount of evidence, that the active principle in the blood of his hens is derived from the cell-nuclei. Human red blood cells, unlike those of birds, have no nuclei, so that to raise a scare about the practice of blood transfusion in man is not justified by his work.

It is worth pointing out that Kushner was not alone in advancing a claim which, if true, is perhaps the most revolutionary step in animal genetics since Muller's discovery of the mutagenic effects of x-rays. The brothers Stroun from Switzerland claimed to have induced heritable changes in White Leghorn hens (including colour, and the shape of the feet and the comb), by transfusions of guinea-fowl blood.

FLOWER WITH TWO FATHERS

One of the two Stroun brothers also reported a case of "bipaternity" in a garden plant which is almost as subversive of the traditional concepts of Mendelian genetics, although again anticipated by claims from the Russian "Michurinist" school of genetics. In Stroun's material, flower colour behaves in ordinary crosses as though under simple Mendelian control. Red crossed with white gives pink; red with yellow gives orange; yellow with white gives yellow. But when white flowers were pollinated with *mixed* pollen from red and yellow flowers, a proportion of the progeny was *orange*, as though both red and yellow male factors had contributed to the fertilisation of a single female ovule. Each such flower could be said to have two fathers!

"CISTRONS" AND "MUTONS"

The most dynamic development of Mendelian genetics today is the ultra-refined analysis of the units of heredity ("genes") which are arranged in linear order along the chromosomes of the cell nucleus. In the old days a gene was a gene. Today, the reader may be surprised to learn, the chromosome is divided up differently according to the genetic process under consideration. We talk either about "cistrons" (units of biochemical function), "recons" (units of recombination), or "mutons" (units of mutation).

A key question today is strangely reminiscent of the central problem of an earlier era of genetics. At that time purely genetical work had shown that the genes were arranged linearly in "linkage groups", the number of which was constant for a given species. Independent microscopic studies had shown that the number of chromosomes visible in the cell nucleus was constant for a given species. Were the linkage groups to be identified with the chromosomes? The answer proved to be "Yes". Today, purely genetical studies have shown that each "cistron" consists of a large number of "mutons" arranged in a linear order. Independent biochemical and crystallographic studies have shown that the DNA (deoxyribonucleic acid) component of the chromosome fibre thought to carry the genetic specificity is also linear, consisting of twin polynucleotide chains arranged in a double spiral. The question now arises: does the order of "mutons" (unit of mutation) within a "cistron" (unit of biochemical function) reflect the order of nucleotides within the polynucleotide chains of which the DNA molecule is composed?

This question was posed, though not answered, at Montreal. But ample evidence was available to demolish the old concept of the gene, according to which the unit of function, the unit of recombination, and the unit of mutation was thought to be one and the same thing. Detailed analyses of individual cistrons by Pontecorvo and his colleagues in the fungus *Aspergillus*, and by Benzer in bacteriophage (a virus parasite in bacteria) have shown that within a single cistron there may be 100 or perhaps even 1000 linearly arranged sites at which mutation can occur.

TAKE ONE RADISH . . .

The lighter sides of the Congress emerge as one remembers the invigorating physical exercise which was inseparable from the pursuit of knowledge. The eight or nine parallel sessions were strung out in linear order (like the genes) for half a mile up a steep hill, which one puffed up and down many times a day. This was to the good,

since the perpetual central heating promoted sleep during lectures while preventing it at night. For relaxation, there was the magnificent exhibition "Genetics in the Service of Man", where,, for example, one could gaze at a radish weighing 28 lb., strange and monstrous goldfish, and a cock with a tail 15 ft. long (these from Japan).

DISORGANISED MOUSE

In addition there was the "Live Linkage Map of the Mouse", contributed by the Jackson Laboratory at Bar Harbour, U.S.A. Attached to each gene figured on vast diagrammatic chromosomes was a little transparent plastic cage, in which sat a mouse or mice exhibiting the corresponding inherited peculiarity. Most perplexing was "disorganised". This gene appears simply to guarantee that its possessor will be very odd in some way or other, without specifying in what particular way. Of two such mice on show, one had a brain rupture, and the other had five legs.

In agreeable contrast to these mice, the organisation of the Congress as a whole was admirable. For this much thanks are due to our Canadian hosts, and especially to the active and generous co-operation of the geneticists of the United States.

The Law of the Sea

Dr JAMES AVERY JOYCE

DISCOVERY'S *special correspondent to the United Nations, Geneva and New York*

"The sea is our common heritage. It is in our common interest that the law of the sea should be certain, that it should be just in its regulation of our various interests, and that it should be so designed as to ensure the preservation of that heritage for the benefit of all mankind." In these words, the purposes of the Conference on the Law of the Sea were epitomised by the President, Prince Wan of Thailand. Looking back at the many problems which were left over for further examination by the eighty-seven participating governments in the "monumental" conference, held at Geneva earlier this year, three issues stand out as being of particular interest to scientists.

First, was the difficulty of defining what is meant by the term "continental shelf". The background of this quite modern problem was stated best by the delegate of India, Mr E. E. Jhirad, who recalled that the expression derived its form from the science of geology and its content from economic interests. It would perhaps be better, he said, that a different term were coined so as to avoid a confusion of ideas. Mr Jean Baz of Lebanon pointed out, however, that "Scientific discoveries will change the shape of the shelf, but the Conference should endorse the concept."

This they did. After five weeks of intensive debate, the continental shelf—never before regulated by a multinational treaty—became the subject of a Convention, consisting of fifteen articles, which was adopted by a vote of fifty-seven in favour, with only three against and eight abstentions. Its provisions refer to "the seabed and subsoil up to the point where the waters above are 200 metres deep or, beyond that limit, if the depth allows exploitation of national resources." Coastal states are given *exclusive rights* to exploit the mineral and other non-living resources of the shelf. Living organisms are included only if they belong to the sedentary species, that is, if, at harvestable stage, they cannot move except in constant physical contact with the seabed or sub-soil. (It will be observed that this definition is equally applicable to sub-marine oil as to oysters, including the pearl-bearing variety!) While granting this right to States, the Convention specifies that it shall *not affect the status of waters above*, which remain as "high seas".

Secondly, regarding the very full discussions on the preservation of marine life, many States appealed for the universal acceptance of scientific methods of fishing. The Japanese delegate, for example, pointing out that Japan's production is about 20% of the total world production, asserted that fishing rights were the nutritional base of the Japanese people and its main animal protein source. It was a well-established principle of international law that high seas fishing should be regulated. Such measures must be based on scientific data. In fact, the text of the proposed Articles on high seas fishing recognised the scientific foundation for any regulation. Japan would, therefore, make known shortly the views of its own experts on scientific regulation.

In similar vein, the Soviet Union delegate, Mr S. B. Krylov, announced that the Soviet Union favoured international regulation of the problems connected with fishing and the control of the national resources of the seas. International regulation was necessary, he agreed, to preserve the resources of the sea for the welfare of people as a whole. There was nowadays plenty of scientific data available, and more is being discovered every day about the stocks of the seas. "Legally, governments have the right to regulate fishing within their territorial waters, but the waters of the high seas cannot be subordinated to any single power." All States, he said, have equal access to the resources of the high seas; yet present-day techniques in fishing have had a detrimental influence on the quality and quantity of stocks of fish in certain areas; and so measures should be adopted to regulate fishing. For these reasons, the Soviet Union, which applied scientific methods for the conservation of fishing stocks, endorsed the draft Articles devoted to the conservation of the living resources of the high seas.

Not to be outdone, apparently, by this demonstration of international-mindedness, the delegate of the United States, Mr William C. Hetherington, asserted that his country had entered into a number of international conservation conventions providing for co-operation among the interestd States and combining their scientific talents. These conventions had proved specially successful in conserving stocks of fur seals, halibut, and salmon. The draft Articles before the Conference would, he hoped, encourage restoration of resources at present overfished, prevention of overfishing in the future, and full utilisation of resources.

Supporting what is known as the principle of "abstention", Mr S. A. Ozere, of Canada, cited as an example the development of the salmon fishery in the Pacific Coast area. Salmon breed in the inland lakes and rivers of Canada and go out as much as a thousand miles to sea before returning to spawn again. Canada had spent

millions of dollars on research and development of the salmon stock and should not, therefore, be threatened by wide-scale fishing by countries which previously had not been engaged at all on fishing for salmon and which made no contribution to the research and development of the salmon stocks.

In the result, the Conference recommended the use of international fishery organisations for the establishment of conservation programmes and also recommended that coastal States should co-operate with these organisations when a species subject to conservation programmes inhabits both the waters under the jurisdiction of that State and the adjacent high seas surveyed by that organisation. The Conference specifically called, too, for humane fishing methods, in a resolution unanimously adopted, and stating, "The United Nations Conference on the Law of the Sea . . . requests States to prescribe, by all means available to them, those methods for the capture and killing of marine life, especially of whales and seals, which will spare them suffering to the greatest extent possible."

Thirdly—closely connected with the foregoing issues—was the ubiquitous threat of pollution, to which, nowadays, has been added the frightening problem of what to do with radioactive wastes. On this last point, Mr Oswald S. Colclough, of the United States, stressed that it was necessary to encourage international action in the field of disposal of radioactive wastes. "Now is the time to initiate action looking towards the effective control of oceanographic disposal of radioactive material", he said. But, recalling that the United Nations Scientific Committee on the Effects of Radiation was at this moment studying the problem, he thought that that was the body which was competent to undertake the necessary studies. (In other words, the practical aspect of this urgent problem was to be put off!)

Naturally, this issue involved a great deal more than scientific waste-disposal. Lt-Cdr Chit Hlaing, of Burma, for example, insisted that the freedom to conduct scientific research should be regulated. "Freedom to contaminate the high seas would destroy all freedom." Everyone now realised the dangers of scientific wastes, he said, and the Conference would definitely have to solve the problem.

At the end of the Conference, in fact, a short Article was included in the Convention on the High Seas, and passed unanimously in the following terms:

> (1) Every State shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organisations.
>
> (2) All States shall co-operate with the competent international organisations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.

But, as these terms were deliberately vague, the Conference adopted also a special resolution on "The Pollution of the High Seas by Radioactive Materials." This resolution noted that "the International Commission for Radiological Protection has made recommendations regarding the maximum permissible concentration of radio isotopes in the human body and the maximum permissible concentration in air and water". It went on to recommend that "the International Atomic Energy Agency, in consultation with existing groups and established organs, having acknowledged competence in the field of radiological protection, should pursue whatever studies *and take whatever action is necessary* to assist States in controlling the discharge or release of radioactive materials to the sea, in promulgating standards, and *in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive materials in amounts which would adversely affect man and his marine resources*" (our italics).

IAEA

Dr JAMES AVERY JOYCE

DISCOVERY'S *special correspondent to the United Nations, Geneva and New York*

For the first time since beginning work last December, the youngest member of the United Nations family gave an account of its first six months of existence to the summer session of the UN Economic and Social Council, which hears the annual reports of the specialised agencies and acts as co-ordinator of their multifarious activities.

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Created at the dawn of the atomic age, which portends a change in the energy pattern of society, the new Agency has been called upon, in the words of its statute, "to accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world". Significantly, the statute goes on to say that the Agency "shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose".

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since the perpetual central heating promoted sleep during lectures while preventing it at night. For relaxation, there was the magnificent exhibition "Genetics in the Service of Man", where,, for example, one could gaze at a radish weighing 28 lb., strange and monstrous goldfish, and a cock with a tail 15 ft. long (these from Japan).

DISORGANISED MOUSE

In addition there was the "Live Linkage Map of the Mouse", contributed by the Jackson Laboratory at Bar Harbour, U.S.A. Attached to each gene figured on vast diagrammatic chromosomes was a little transparent plastic cage, in which sat a mouse or mice exhibiting the corresponding inherited peculiarity. Most perplexing was "disorganised". This gene appears simply to guarantee that its possessor will be very odd in some way or other, without specifying in what particular way. Of two such mice on show, one had a brain rupture, and the other had five legs.

In agreeable contrast to these mice, the organisation of the Congress as a whole was admirable. For this much thanks are due to our Canadian hosts, and especially to the active and generous co-operation of the geneticists of the United States.

The Law of the Sea

Dr JAMES AVERY JOYCE

DISCOVERY'S *special correspondent to the United Nations, Geneva and New York*

"The sea is our common heritage. It is in our common interest that the law of the sea should be certain, that it should be just in its regulation of our various interests, and that it should be so designed as to ensure the preservation of that heritage for the benefit of all mankind." In these words, the purposes of the Conference on the Law of the Sea were epitomised by the President, Prince Wan of Thailand. Looking back at the many problems which were left over for further examination by the eighty-seven participating governments in the "monumental" conference, held at Geneva earlier this year, three issues stand out as being of particular interest to scientists.

First, was the difficulty of defining what is meant by the term "continental shelf". The background of this quite modern problem was stated best by the delegate of India, Mr E. E. Jhirad, who recalled that the expression derived its form from the science of geology and its content from economic interests. It would perhaps be better, he said, that a different term were coined so as to avoid a confusion of ideas. Mr Jean Baz of Lebanon pointed out, however, that "Scientific discoveries will change the shape of the shelf, but the Conference should endorse the concept."

This they did. After five weeks of intensive debate, the continental shelf—never before regulated by a multinational treaty—became the subject of a Convention, consisting of fifteen articles, which was adopted by a vote of fifty-seven in favour, with only three against and eight abstentions. Its provisions refer to "the seabed and subsoil up to the point where the waters above are 200 metres deep or, beyond that limit, if the depth allows exploitation of national resources." Coastal states are given *exclusive rights* to exploit the mineral and other non-living resources of the shelf. Living organisms are included only if they belong to the sedentary species, that is, if, at harvestable stage, they cannot move except in constant physical contact with the seabed or sub-soil. (It will be observed that this definition is equally applicable to sub-marine oil as to oysters, including the pearl-bearing variety!) While granting this right to States, the Convention specifies that it shall *not affect the status of waters above,* which remain as "high seas".

Secondly, regarding the very full discussions on the preservation of marine life, many States appealed for the universal acceptance of scientific methods of fishing. The Japanese delegate, for example, pointing out that Japan's production is about 20% of the total world production, asserted that fishing rights were the nutritional base of the Japanese people and its main animal protein source. It was a well-established principle of international law that high seas fishing should be regulated. Such measures must be based on scientific data. In fact, the text of the proposed Articles on high seas fishing recognised the scientific foundation for any regulation. Japan would, therefore, make known shortly the views of its own experts on scientific regulation.

In similar vein, the Soviet Union delegate, Mr S. B. Krylov, announced that the Soviet Union favoured international regulation of the problems connected with fishing and the control of the national resources of the seas. International regulation was necessary, he agreed, to preserve the resources of the sea for the welfare of people as a whole. There was nowadays plenty of scientific data available, and more is being discovered every day about the stocks of the seas. "Legally, governments have the right to regulate fishing within their territorial waters, but the waters of the high seas cannot be subordinated to any single power." All States, he said, have equal access to the resources of the high seas; yet present-day techniques in fishing have had a detrimental influence on the quality and quantity of stocks of fish in certain areas; and so measures should be adopted to regulate fishing. For these reasons, the Soviet Union, which applied scientific methods for the conservation of fishing stocks, endorsed the draft Articles devoted to the conservation of the living resources of the high seas.

Not to be outdone, apparently, by this demonstration of international-mindedness, the delegate of the United States, Mr William C. Hetherington, asserted that his country had entered into a number of international conservation conventions providing for co-operation among the interestd States and combining their scientific talents. These conventions had proved specially successful in conserving stocks of fur seals, halibut, and salmon. The draft Articles before the Conference would, he hoped, encourage restoration of resources at present overfished, prevention of overfishing in the future, and full utilisation of resources.

Supporting what is known as the principle of "abstention", Mr S. A. Ozere, of Canada, cited as an example the development of the salmon fishery in the Pacific Coast area. Salmon breed in the inland lakes and rivers of Canada and go out as much as a thousand miles to sea before returning to spawn again. Canada had spent

millions of dollars on research and development of the salmon stock and should not, therefore, be threatened by wide-scale fishing by countries which previously had not been engaged at all on fishing for salmon and which made no contribution to the research and development of the salmon stocks.

In the result, the Conference recommended the use of international fishery organisations for the establishment of conservation programmes and also recommended that coastal States should co-operate with these organisations when a species subject to conservation programmes inhabits both the waters under the jurisdiction of that State and the adjacent high seas surveyed by that organisation. The Conference specifically called, too, for humane fishing methods, in a resolution unanimously adopted, and stating, "The United Nations Conference on the Law of the Sea . . . requests States to prescribe, by all means available to them, those methods for the capture and killing of marine life, especially of whales and seals, which will spare them suffering to the greatest extent possible."

Thirdly—closely connected with the foregoing issues—was the ubiquitous threat of pollution, to which, nowadays, has been added the frightening problem of what to do with radioactive wastes. On this last point, Mr Oswald S. Colclough, of the United States, stressed that it was necessary to encourage international action in the field of disposal of radioactive wastes. "Now is the time to initiate action looking towards the effective control of oceanographic disposal of radioactive material", he said. But, recalling that the United Nations Scientific Committee on the Effects of Radiation was at this moment studying the problem, he thought that that was the body which was competent to undertake the necessary studies. (In other words, the practical aspect of this urgent problem was to be put off!)

Naturally, this issue involved a great deal more than scientific waste-disposal. Lt-Cdr Chit Hlaing, of Burma, for example, insisted that the freedom to conduct scientific research should be regulated. "Freedom to contaminate the high seas would destroy all freedom." Everyone now realised the dangers of scientific wastes, he said, and the Conference would definitely have to solve the problem.

At the end of the Conference, in fact, a short Article was included in the Convention on the High Seas, and passed unanimously in the following terms:

> (1) Every State shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organisations.
>
> (2) All States shall co-operate with the competent international organisations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.

But, as these terms were deliberately vague, the Conference adopted also a special resolution on "The Pollution of the High Seas by Radioactive Materials." This resolution noted that "the International Commission for Radiological Protection has made recommendations regarding the maximum permissible concentration of radio isotopes in the human body and the maximum permissible concentration in air and water". It went on to recommend that "the International Atomic Energy Agency, in consultation with existing groups and established organs, having acknowledged competence in the field of radiological protection, should pursue whatever studies *and take whatever action is necessary* to assist States in controlling the discharge or release of radioactive materials to the sea, in promulgating standards, and *in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive materials in amounts which would adversely affect man and his marine resources*" (our italics).

IAEA

Dr JAMES AVERY JOYCE

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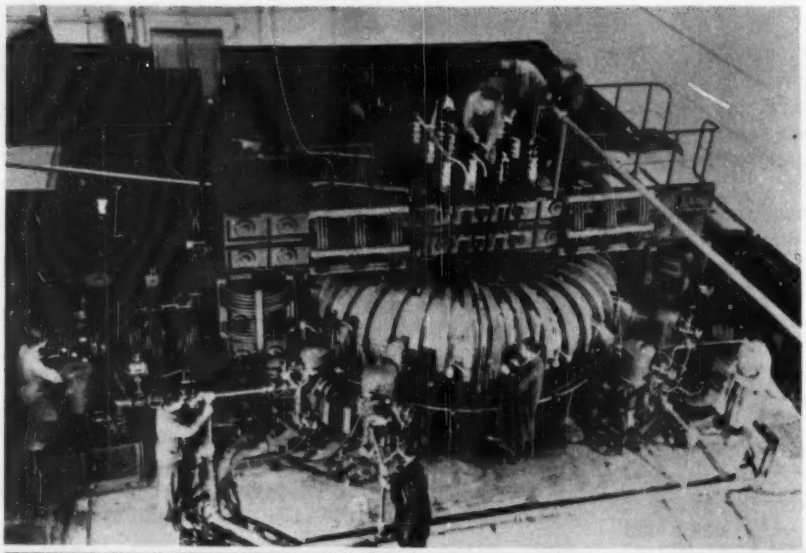
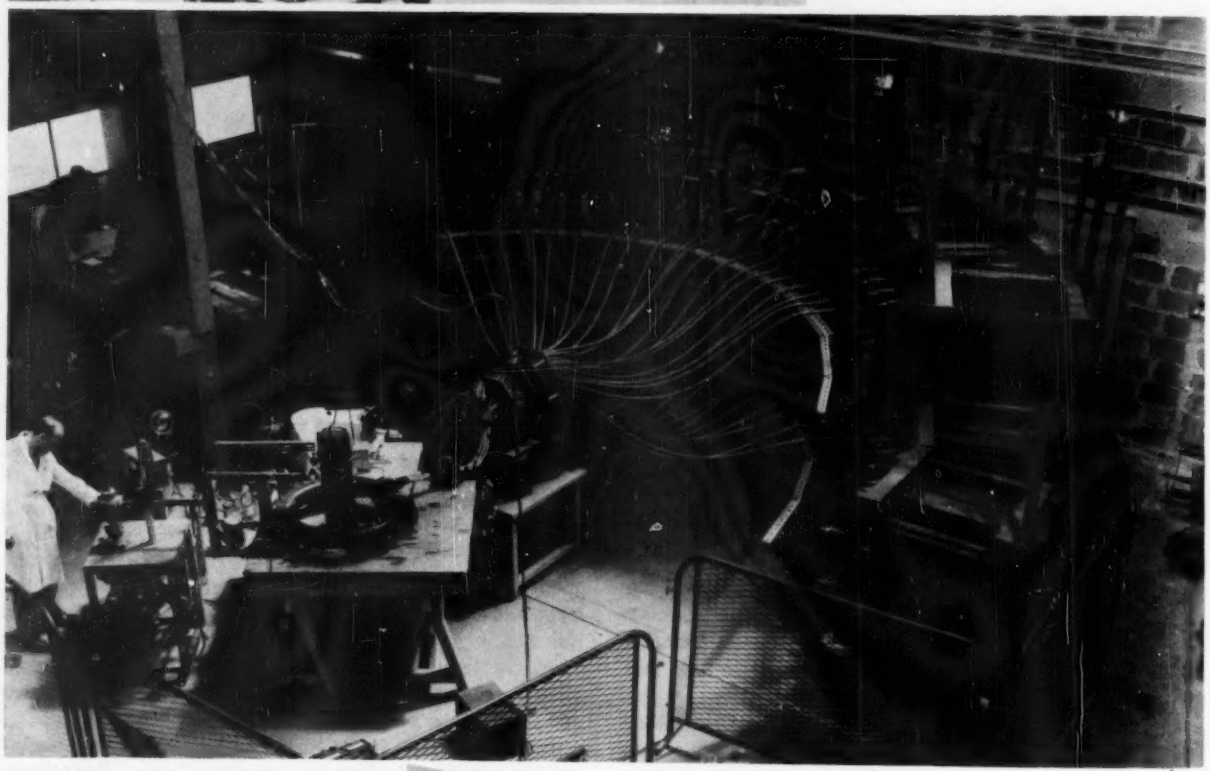


FIG. 1. (*Left*) **The Russian ZETA-ALPHA.** The circular discharge-tube for fusion experiments, called ALPHA, used at the Moscow Institute for Atomic Research.

FIG. 2. (*Below*) **The French ZETA.** A toroidal discharge-tube with its bank of condensers at the Laboratoire de la Fusion at the French Atomic Energy Research Centre at Saclay.



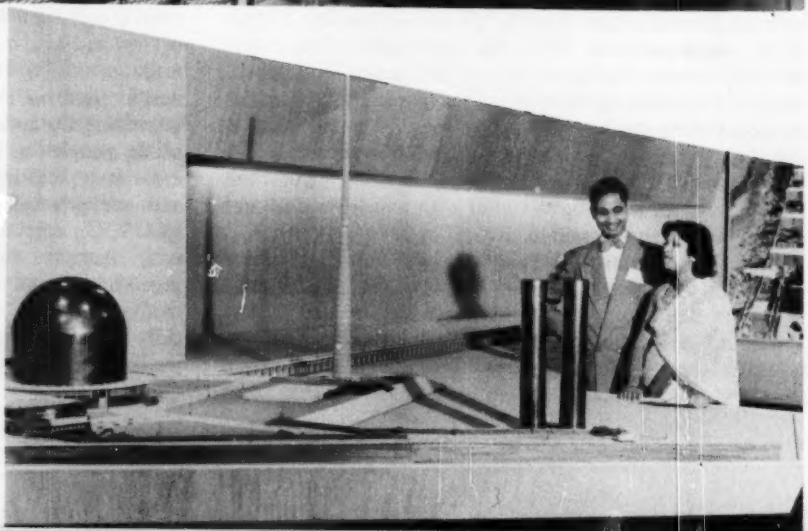


FIG. 3. **The First Indian Atomic Reactor.** A model of the NRX reactor to be erected near Bombay was shown at the Geneva Scientific Exhibition. Dr H. D. Sharma, Officer in Charge of the Radio Chemistry Division, explaining to another Indian visitor that it is heavy-water moderated and that it is cooled with sea-water; this is done because ordinary water is extremely scarce in the locality where it will be erected. Its power output will be 40 MW and it should be ready towards the end of 1958.

(The photographs in Geneva were specially taken for DISCOVERY *by John Moyes)*

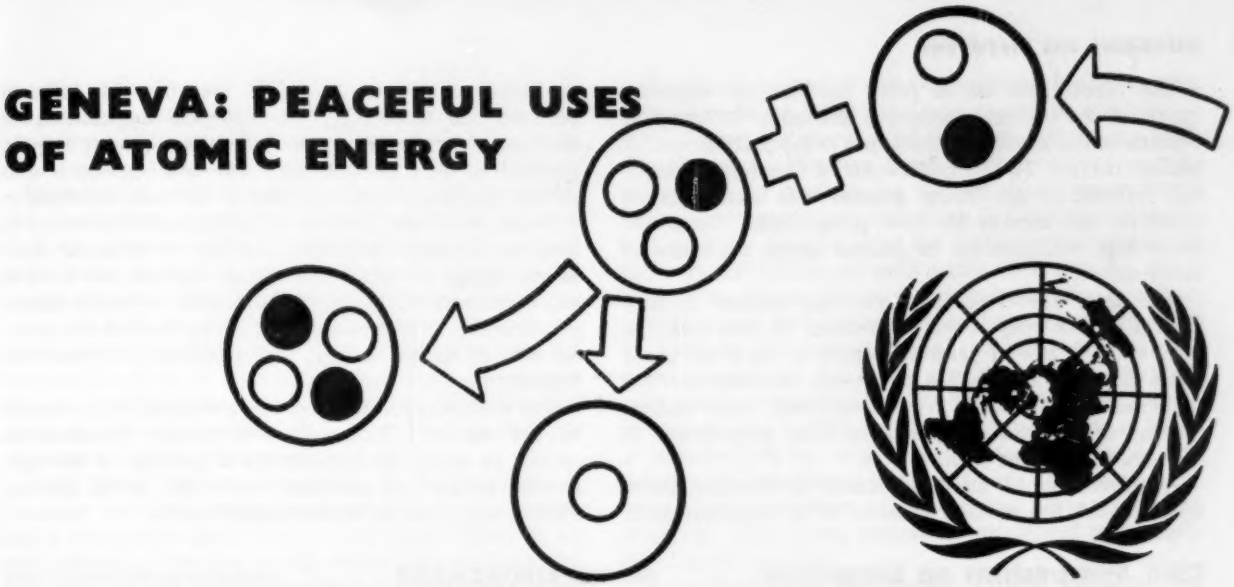
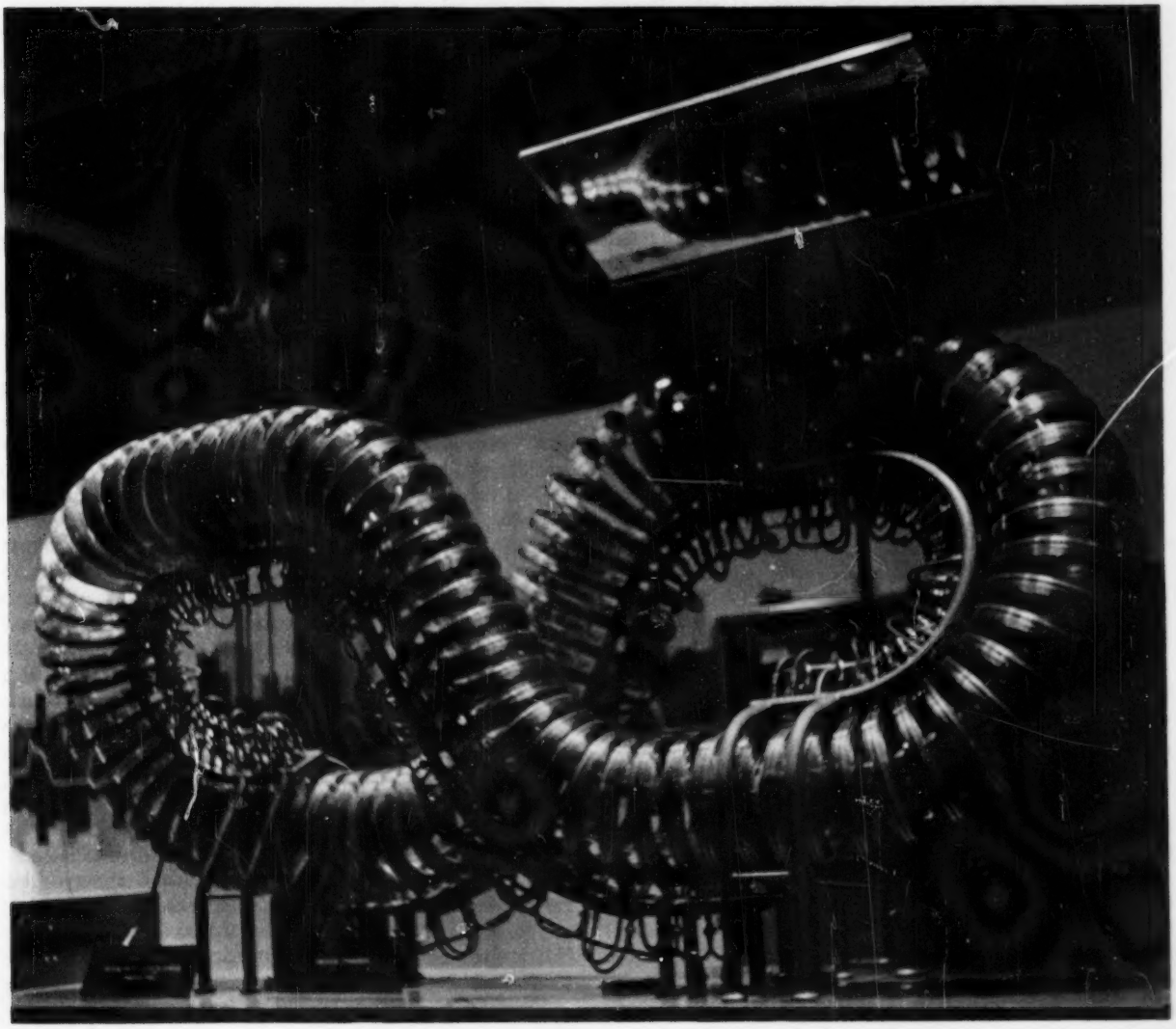


FIG. 4. **Full Size Model of the Figure "8" STELLARATOR.** The principle of fusion here employed is to heat a cold gas in a containing magnetic field by electrical discharge and by magnetic squeezing. It was constructed by Princeton University and the model was so arranged that the discharge glows could be watched by the visitors at the scientific exhibition.



The report goes on to point out that an important sector of the Agency's technical assistance to Members consists in the training of specialists in the peaceful uses of nuclear energy. To this end awards of research and training fellowships are being granted and exchanges of scientists and experts are now going ahead. Some 150 fellowships will probably be granted during the course of this year.

The need for establishing *regional* nuclear training centres is also being actively examined. A field study, in fact, which is now in progress in most of the countries of Latin America, is expected to provide valuable data for implementing this need. When established, these nuclear training centres will strengthen the local programmes of Member States of the whole region.

Another form of direct assistance to Member States which IAEA has in hand consists of the organisation of conferences and symposia on the use of radioisotopes in research and technology, the biological applications of isotopes, the economic aspects of nuclear power, and the disposal of radioactive wastes. The new Agency is also undertaking the provision of central technical information services, which are likely to be particularly important in assisting countries only just starting to organise their atomic energy services and activities. Indeed, this kind of initial guidance might help to bring about a certain degree of uniformity in the various national legislations on peaceful uses of nuclear energy, thus facilitating international regulation.

The dissemination of special technical studies, prepared by the Agency's staff, will undoubtedly contribute to spread, as widely as possible, the knowledge of the continuous progress of scientific discoveries in the field of nuclear energy and its manifold applications.

Ciba Symposium on Etruscans

Dr M. SINISCALEO *Instituto di Genetica dell'Università, Naples*

The early history of the Etruscans is merged into the broader problem of the prehistory of the Italic people; and this alone indicates the difficulties one meets when attempting to trace back their origin on the basis of the available historical sources. It is practically impossible from these to draw a sharp line of demarcation between legend and reality. The situation is such that some students in the field of Etruscology are still doubtful about some very elementary issues. Did the Etruscans ever exist as a differentiated ethnic group? If they did, were they an "autochthonous" group or did they come from outside? Archaeological and linguistic evidence supports the hypothesis that they came from some unspecified region of the Middle East and settled in Etruria. This, however, does not solve the "autochthonous-heterochthonous" dilemma since the influence of an outside civilisation would, in fact, be well established through the arrival of a limited number of individuals who succeeded in becoming the ruling class among a rather undeveloped indigenous group.

But there is one point at least on which all students of humanistic disciplines seem to agree, namely the period in which the Etruscan civilisation emerged. If the Etruscans came from outside, they must have come around the end of the 8th century B.C. How many they were, where they came from, where they first landed, where they spread to—these are issues on which the experts prefer not to commit themselves.

Could modern history help to find an answer to these problems? This hope was partly responsible for the Ciba Foundation's symposium on the Etruscans, held in London from April 23–5. The Etruscologists disarmingly admitted that they knew "practically nothing about the Etruscans", and requested help from their colleagues in other fields.

Biologists were consulted because they have learned in the last half-century to understand the mechanism of biological inheritance. They can therefore predict, by carefully studying a population of parents, how the population of their children will look, and so forth. With some limitations, the opposite kind of induction is also possible. For instance, since the distribution of genetically controlled characteristics is known to be fairly stable over a long period of time (although it is certainly altered by natural selection in evolutionary time) the finding of marked differences in the distribution of one or more genetical traits among two living populations may be taken as indicative of a different ethnical derivation.

The idea of using physical characteristics as a means to follow the course of human evolution is not a new one. It is clear that such characteristics should not be too ephemeral; for instance, they should not be too susceptible to possible modifications by environmental influence. On the other hand, it would be desirable to deal with characteristics which could be identified in ancient human remains.

It is for this last reason that the importance of studying the patterns of some body measurements has been particularly emphasised in the past. Bones, because they are hard, were also thought to be less influenced by environmental factors. This view is not shared by modern workers for it is hardly necessary to point out, in the light of the recent available medical evidence, the influence that some environmental agents such as sanitation, infectious diseases, and food may play as factors controlling the growth of the skeletal parts of the body.

The modern anthropologist prefers therefore, whenever possible, to measure differences between human groups in terms of much simpler inherited traits such as blood groups and other genetically controlled examples of biochemical polymorphisms due to single gene differences.

Unfortunately, not all of these new tools that genetics has handed over to anthropology are equally suitable.

It is generally agreed that the distribution of inherited characteristics may be more or less influenced by natural selection. That is to say that some characters are better adapted than others to a particular environment; and, therefore, the gene or genes which are responsible for them tend to increase in their relative frequencies.

Differential adaptiveness of inherited characteristics to different environments limits in some way their efficiency as means for anthropological research. It is conceivable, for instance, that the distribution of gene frequencies for any genetical trait is likely to be altered if the ecological background of a human group changes, or if the group migrates from a given environment to a different one.

Nevertheless, it must be borne in mind that, with the

exception of a few well identifiable cases, the changes in the genetical structure of human populations probably take place in a period of time which is far greater than the order of magnitude of the historical periods we are interested in.

Therefore, it is fairly safe to conclude that biological and genetic data, critically weighed in the light of all other available information from humanistic disciplines, might prove to be very useful to the problem of tracing back, on a relatively short-term basis, the racial history of Man.

To go back to the Etruscans, the problem may be approached either through the study of human remains, or through the study of populations now living. As regards the first, unfortunately only a few dozen so-called Etruscan skulls have been preserved with care (we are told) and they are scattered all over European museums.

Prof. Neppi Mòdona, Secretary to the Institute of Etruscan and Italic Studies, mentioned at the Symposium that a referendum made with the purpose of collecting all the available information on this material has not been very successful. On the whole, the archaeologists seemed rather sceptical about the possibility of getting reliable data from these sources and urged the biologists to help in devising appropriate methods of collection and storage for scientific purposes so that no further material should be wasted.

Biologists, in their turn, are not very hopeful at present about the potential value of the osteometric investigations. Furthermore, Dr Barnicot and Mr Brothwell (University College, London) have shown that the skulls labelled as "Etruscan" in the British Museum showed no evidence of belonging to a clearly differentiated physical group, and they feel that there is not very much to be gained by anthropometric studies.

On the other hand, it was very unlikely that the investigations on blood group differences would be extended to bones, because of the unreliability of the techniques available at present. However, it was generally agreed to make every effort to preserve the material becoming available from current and future excavations in Etruscan and neighbouring areas because, once the techniques are perfected, this material will be of inestimable value for the direct study of the genetic structure of the populations concerned.

With regard to the study of populations now living, the "autochthonous-heterochthonous" dilemma will be genetically solved, if it proves possible to show that the archaeological and linguistic boundaries of ancient Etruria correspond to a modern population whose genetic structure is different from that of the neighbouring ones. Population data for the distribution of blood groups and other genetic traits have so far been collected within areas where geographical limits do not necessarily correspond to the early historical boundaries.

A revaluation of the already existing data and the collection of new information, in the light of historical, linguistic and archaeological evidence, could be extremely valuable. But is there really any hope of finding an answer to a problem which was already an old one at the times of Herodotus and Hellenicus? From a biological point of view one must be rather sceptical. Perhaps the "Etruscan problem" will remain a "myth" even in the atomic age. But what will certainly count is the mutual understanding that students of so many different disciplines shared throughout the recent meeting, and their enthusiasm to help each other to widen the narrow perspective through which every expert sees his own facet of reality.

Electricity and World Progress

E. W. GOLDING

Electrical Research Association, Leatherhead

The theme of the British Electric Power Convention held recently at Brighton, under the chairmanship of Sir George H. Nelson, was "Electricity and World Progress" and the papers presented dealt with Britain's contribution towards world electrification. It is, of course, commonly accepted that national prosperity increases in almost direct proportion to the consumption of electricity per head of population and the average annual increase in consumption of this energy for the world has been just over 10% during the last eight years. This rate of increase applies very closely in all five continents but, while the per capita consumption in the Americas is over 2200 units, it is less than 100 units in Asia where about half of the present world population is concentrated. The picture thus presented is one in which the need for electrical development in the less industrialised countries is sharply emphasised and British manufacturers are naturally keenly interested in the possibilities, which are obvious. The installed capacity of generating plant for the world is increasing at about 7% per annum.

Although by no means uniformly distributed, much water power remains to be developed all over the world and this represents a very important national asset for any country which possesses it. It is difficult to obtain reliable and up-to-date figures for the world potential of water power because new surveys are being made continuously and, as technical advances—particularly in high tension transmission—are made, the power that can be developed economically increases. There is little doubt, however, that a world potential of over 500 million kW (on a basis of minimum water flow) is available and, of this, only 118 million had been developed in 1956. Only in Western Germany, Italy, and Switzerland is the present development in excess of 50% of the total potential, while in India, the continent of Africa, and some countries in South America the percentage is under five. In 1956 just over 30% of the total world production of electrical energy was produced from water power.

Water power being an inexhaustible source of energy, it should be developed whenever schemes for its use are likely to be economic, and especially when the power is not so far from centres of population that very high voltage transmission lines are needed to transport the energy. Modern hydro-electric stations are now costing between £100 and £150 per kW installed but have a life of fifty to eighty years, so that depreciation charges are low and the energy produced is cheap.

For more than 100 years water turbines have been made in Britain, but until the 1920's they were of fairly small size. Especially since World War II, very rapid strides have been made in the construction of hydro-electric plant and now Britain makes turbines as large as those made in any other country with units of 200,000 h.p. now under construction. A new type of water turbine, the Deriaz,

actually a Francis type of turbine with movable blades, can be used with heads up to 600 ft. This is especially suitable for use as a combined pump and turbine needed for "pumped storage" schemes. When the load on an electric supply system is low, power can be used to pump water in a high reservoir from which it can be drawn down later, when the power demand rises, through a turbine to re-generate the power. The reservoir thus provides storage of energy. Several pumped storage schemes, which will be needed later to absorb the continuous output from large nuclear power-stations, are under construction in Britain. These include the 300-MW Ffestiniog Scheme in Wales which, when completed, will be the largest in the world. The pumps, for a head of 1062 ft., will absorb 93,600 h.p. and will be the largest capacity vertical-shaft pumps in existence.

Sir Christopher Hinton and Sir Claude Gibb reviewed the development of nuclear power for the generation of electricity in Britain and overseas. They called attention to the fact that it was not national prestige, but the actual need to meet rapidly rising power demands with the prospect of insufficient coal production, that caused nuclear developments in Britain, although primarily for defence, to follow lines which would enable them to be used for electricity generation. The construction, for the electricity generating boards, of the twelve or fifteen power stations with a total capacity of between 5000 and 6000 MW. by 1966 was originally estimated to cost over £900 million. To compete with conventional coal-fired plant, in cost of energy produced, a nuclear station must be run continuously as fully loaded as possible. Hence the development of pumped storage schemes in Britain to absorb energy at off-peak periods. Even so, by 1966, the nuclear capacity might be larger than can be absorbed when the power demand is at its lowest—during summer week-ends —so that some reduction of output would be necessary. The capital cost of these stations—at present about £110 per kW for the largest—must therefore be brought down and, since this cost depends largely upon the highest temperature that can be achieved in the reactor, there is a very active search for materials with high melting points to use as "canning" for the fuel elements. Magnesium alloy has been used but it is not suitable for temperatures exceeding 500°C. Zirconium is an alternative for water-cooled reactors but cannot be used with carbon dioxide cooling because it reacts with that gas at temperatures above 500°C. Beryllium, with a melting point of 1285°C, might be suitable, but it is a very difficult material to handle and to fabricate, is expensive and, moreover, is extremely toxic.

Suggestions made at the conference towards improving the economy of nuclear power generation in Britain included speeding up the electrification of the railways to provide a large night load by running freight trains, and the construction of more pumped storage schemes in the Scottish Highlands, where there are many favourable sites, although very high-voltage transmission at perhaps 500,000 volts or more would be needed to take the power down to industrial centres in England. At the CIGRE meeting in Paris recently the Russian delegates described their experiences with long-distance transmission at 400,000 volts. Their intention is to convert the system to 500,000 volts in the near future while still further advances —to as high as 660,000 volts—are envisaged when present research on these very high tensions is completed.

A factor influencing the energy cost in nuclear generation is the value to be given to the plutonium which can be produced as a by-product and the announcement last month by the Government that it intended to use some of the large new power stations also as producers of plutonium for defence purposes will certainly improve the economy and reduce the cost of the electrical energy produced.

The four British nuclear generating stations now being built, having capacities between 300 and 500 MW, are based, technically, on the very successful 38 MW Calder Hall station which has proved the graphite-moderated, gas-cooled reactor to be the most economical in the world for large outputs. For other countries which, in the future, will need nuclear stations because of their lack of adequately large indigenous resources of energy, a somewhat smaller size might be better suited. The actual size required will depend upon many factors, including the characteristics of the power demand and the availability of suitable sites for hydro-electric and pumped storage schemes.

To supply electricity economically in a thinly populated district, no matter whether this be in Britain or in less industrialised areas abroad, a prime requirement is to build up the consumers' loads to the highest possible amount. Hence the importance of the efforts to evolve equipment and techniques for the application of electricity to agriculture which is, of course, the main occupation of such areas. In an impressive display of electro-agricultural equipment at the Bristol Royal Show (July 1 to 4) there was much that could be applied universally. It included electrically operated, crop-drying plants for both fodder and grain or seeds, poultry-rearing apparatus and an automatic "pig parlour" in which all the pig's needs in food, light, heating, ventilation, and cleaning were catered for, thus saving up to 20% in food and 90% in labour. So "automation" is not confined to industry.

London: XVth International Congress of Zoology

Dr J. L. CLOUDSLEY-THOMPSON

Lecturer in Zoology, King's College, London

It is appropriate that the XVth International Congress of Zoology should have been held in London during the year of the Darwin-Wallace centenary. No generalisation is of deeper significance than the concept of evolution to which attention was focused by Charles Darwin and Alfred Wallace in their joint communication to the Linnean Society on July 1, 1858. For the paper, "On the tendency of species to form varieties; and on the perpetuation of varieties and species by natural means of selection", proved unmistakably that animals and plants have become what they now are in consequence of evolutionary changes; they were never specially created.

At the inaugural meeting in the Royal Albert Hall, a presidential address to the Congress delivered by Sir Gavin de Beer was followed by a lecture from Sir Julian Huxley entitled "The Emergence of Darwinism". In this it was pointed out that man's destiny is to be the chief agent for the future of evolution in the world. Only in and through

man can any further major advance be achieved; the future is no longer merely an affair of hopes and fears, it can be rationally defined on the basis of scientific knowledge.

The remainder of the official programme consisted of nearly 500 sectional papers and addresses. It is not normally easy to detect any pervading tendency throughout contemporary zoology, but at the International Congress several meetings were specially devoted to subjects related to the theme of evolution. Papers varied in scope from descriptions of *Neopilina* to the transplantation of nuclei in *Amoeba* and accounts of experiments on the comparative physiology and development of behaviour patterns. *Neopilina galatheae*, an archaic deep-sea mollusc of a kind known from fossils to have existed over 330 million years ago, was recently found, by the Danish *Galathea* Expedition, living at a depth of 3570 m. in the Pacific Ocean. The chief importance of this discovery lies in the fact that it shows the Mollusca to have originated from segmental ancestors.

In other sessions, Prof. A. J. E. Cave said that Neanderthal man stood and walked erect. The conception of a hunched attitude was based on accounts of a skeleton badly deformed by osteo-arthritis. Dr H. Harlow concluded from experiments on the development of affection in infant monkeys that the ideal mother, "never angry, never cross", could be constructed from "a block of wood, covered by sponge rubber, and sheathed in a terry-cloth skin". From a psychological point of view, the mother is not essentially a source of food, but a source of comfort and encouragement to her baby.

Amongst the papers in the Behaviour Section, Dr W. H. Thorpe's showed that the song of the chaffinch contains both inherited and learned components, and Dr J. L. Cloudsley-Thompson's indicated the part played by inherited diurnal rhythms of activity and nocturnal habits in the conquest of the land by the Arthropoda. Dr P. E. Ellis described the development of gregarious behaviour in locust nymphs, and Dr E. A. R. Fabricius outlined the importance of visual stimuli in the release of nest-digging movements among spawning salmonid fishes. At the final plenary session, Prof. J. Millot spoke on the Coelacanth, *Latimeria chalumnae*, the last of the Crossopterygian fishes.

Naturally, many excursions were organised, both during and after the Congress. Exhibits, film shows, and receptions were provided to cater for every spare moment, and special entertainments were arranged by the Ladies' Committee. Everyone who has attended congresses abroad in recent years will have been impressed by the high standard and efficiency usually achieved. It is gratifying, therefore, to be able to report that the XVth International Congress of Zoology maintained a standard of which British scientists could be proud. Their thanks are due to the Secretaries-General (Prof. H. R. Hewer and Dr G. E. Newell), the Registrar (Capt. N. D. Riley, C.B.E.), and the other officials whose labours over many months contributed so much to the final success.

New Science at Farnborough

ROY ALLEN

Farnborough 1958 was notable for being bigger and better in all respects than the show of the year before. While the Society of British Aircraft Constructors' annual display and exhibition is an attraction mainly because of its *flying*, the static park and the exhibition hall have a very great deal to interest the scientific visitors, and this year had more interesting devices on show than ever before.

Among the items displayed, was one of particular importance on the Ministry of Supply's stand. A three-dimensional, continuous, automatic measuring machine showed how inspection can be made of aircraft and components, and as an example, this had a plate from a Napier Gazelle gas generator engine installed. The machine was tape-controlled, and any error in its working caused a movement of the measuring head stylus, which was indicated and recorded. This device was bordered by a pilot's view simulator, which makes available on the ground a view which is normally obtained only in flight. The "pilot" is given a perspective view in the forward direction, and this changes in accordance with the movements of the aircraft. The view is artificial, being synthesised by a special optical technique.

The Royal Radar Establishment, whose work has become so important, showed a liquid-cooled chassis for electronic apparatus. Two examples of this chassis were to be seen, one in aluminium and the other using nickel. Another research group which has done recent work in the electronics field is W. H. Sanders Ltd; it had on display a range of flexible waveguides, which have seen increasing use in ground and airborne radar systems. Sanders is a comparatively new company working in this increasingly important field of aviation.

Long-established companies such as Marconi's had much to show in the radio and radar fields, and also in the instrument field, for the company exhibited EVA, an electronic velocity analyser, capable of measuring accurately the speeds of guided weapons, projectiles, aircraft, or ground vehicles. EVA's job is to eliminate the task of computing performance figures, which usually calls for the provision of an elaborate system of instrumentation.

Another well-known company, the Sperry Gyroscope Co. Ltd, showed their Introview non-destructive testing device for examining metal tubes, to assess their condition. On the Sperry stand also was one of the earliest types of Inertial Navigation Systems for aircraft, which was first developed in 1954 and has since formed the basis for almost all inertial navigation systems. The product of a team of engineers at Sperry and technicians at the RAE, Farnborough, the device was called by one "the Daddy of the type employed in the U.S. submarine *Nautilus*".

S. G. Brown Ltd showed their master reference gyro, which is cleverly designed to obviate the need for numerous gyroscopes in an aeroplane, by performing two essential tasks through the one master-device. This is done by one gyro in the MRG always pointing to magnetic north and the other always remaining parallel to the earth's surface.

New metals were a feature of Farnborough, and visitors were treated to displays of parts and engine blades in beryllium, vanadium, niobium, and zirconium, as well as in the better-known metal—titanium. ICI (Metals Division)

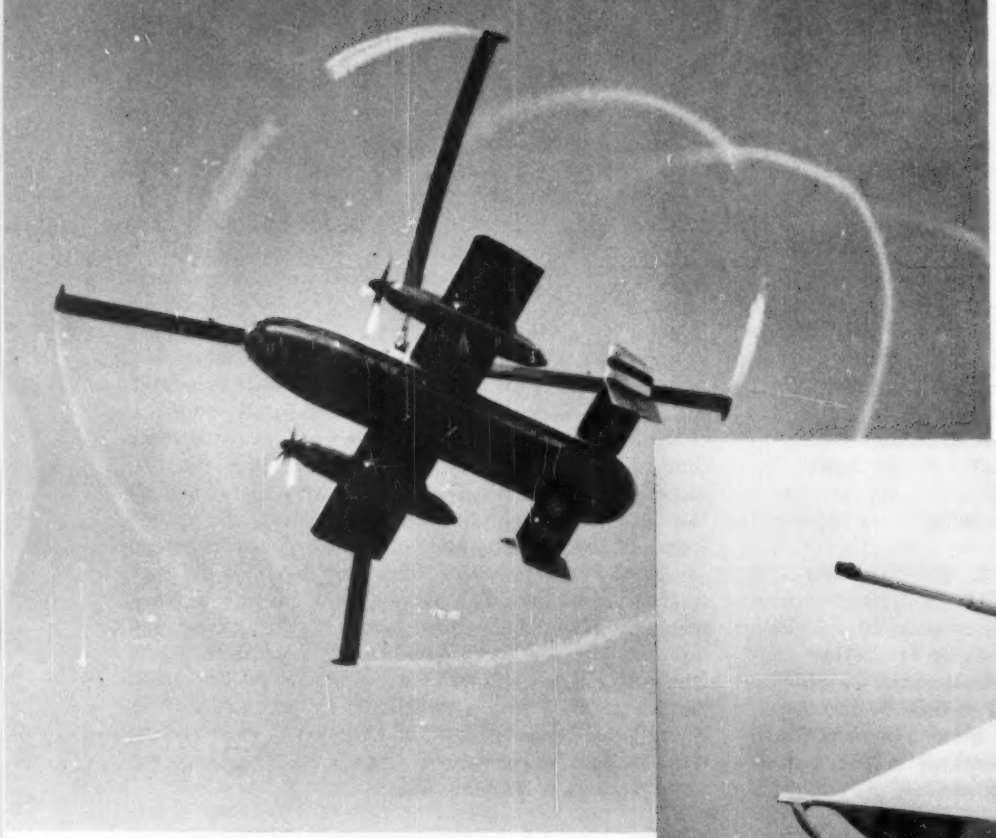


FIG. 1. The Fairey Rotodyne. This vertical take-off airliner has for its main power units two Napier Eland propeller turbines and for its rotor power units four Fairey Pressure Jets. Cruising speed 185 m.p.h., maximum range 450 statute miles, maximum payload 48 passengers or 12,000 lb.

(Shell photograph)

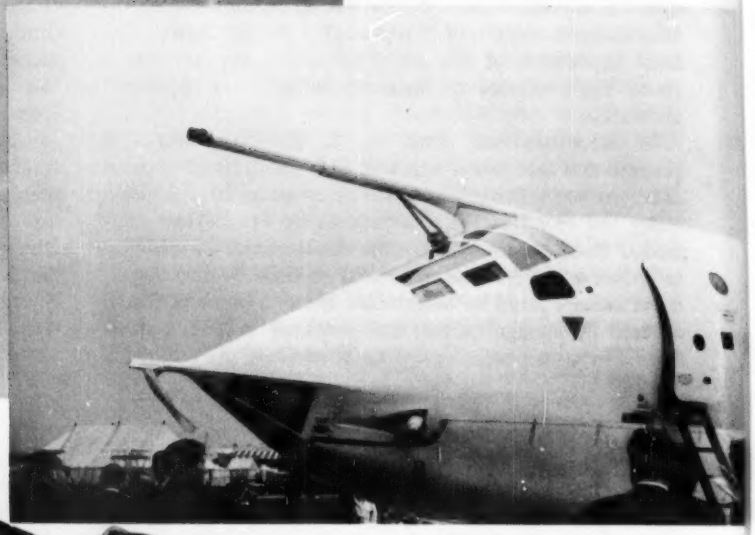


FIG. 2. Handley Page Victor bomber nose. Picture shows new flight-refuelling probe and entry door.

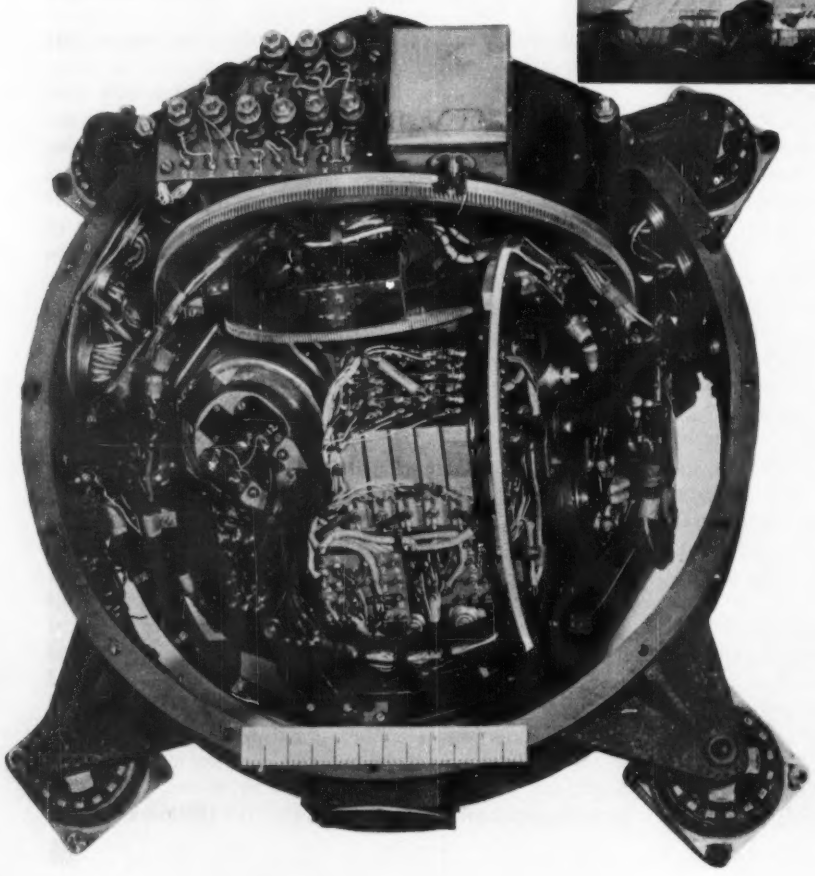


FIG. 3. The early design of an Inertia Guidance Stable Platform shown at Farnborough by Sperry Gyroscope Co. Ltd.

has so improved titanium work in the past year or so that production costs have been cut by some 60%.

With regard to the aircraft and the engines themselves: there were no less than eight new aircraft to be seen this year—four of which were helicopters. Notable among these were the NA-39 naval strike aircraft, the elegant Comet IV (see front cover), and the cleverly contrived Fairey Rotodyne, a helicopter-cum-aeroplane. Technical prowess in the power plant field was evident from new Rolls-Royce engines showing the new jet propulsion engine the RB-145, which is designed for light jet aircraft and develops 2750 lb. thrust, and from Alvis who showed the new Leonides 531, a piston engine designed to replace the lower-powered engine of the same name. Napier's showed the double-Scorpion rocket motor, and Armstrong Siddeley Motors a new one called the PR-23, indicating the company's faith in the small rocket for it provides some 500 lb. thrust.

As always, Farnborough provided a wealth of information and entertainment to visitors and participators alike.

Amino Acids as Anti-Tumour Agents

CECILIA M. O'CONNOR, B.Sc. *CIBA Foundation, London*

Prof. Franz Bergel, of the Chester Beatty Research Institute, took the Chair at a recent Ciba Foundation Symposium* on Amino Acids and Peptides with Antimetabolic and Cytotoxic Properties. Developments in research on amino acids and peptides in general, over the past few decades, have provided the research worker—organic chemist, biologist, or clinician—with a complexity of challenging problems. By limiting the scope of the symposium to the antimetabolic and cytotoxic aspects, and excluding 5-hydroxytryptamine and the iodinated thyronine field, together with polypeptides of a hormonal nature, it was hoped that this multidisciplinary group would achieve a most helpful synthesis of ideas on the chemistry, biochemistry, microbiology, and clinical application of certain types of compounds, with special reference to structure/activity relationships and mechanisms of action. The main emphasis was on the problem of cancer and the search for anti-cancer agents.

This symposium may be remembered too by the happy coincidence that three of the people associated with it—Dr E. P. Abraham, Prof. A. J. Birch, and Prof. A. Haddow—were elected to Fellowship of the Royal Society in the same week it was held.

Prof. K. Balenović of Zagreb, who opened with a paper on the stereochemistry of amino acids, dealt with methods for determining the absolute configuration of naturally occurring β-amino acids; with evidence for the absolute configuration of some hitherto undetermined ones.

Prof. E. F. Gale (Cambridge) discussed his studies on the mode of action of chloramphenicol, with its implication for the mechanism of protein synthesis. Prof. Gale's results indicate that chloramphenicol blocks a particular stage in the mechanism of nucleoprotein synthesis, and that it does not affect the incorporation of all amino acids in the same way.

The mechanism of action of amino acids in cancer chemotherapy, in relation to nutritional factors, remains an important problem. Some information on this was brought forward by Prof. H. E. Skipper (Alabama), who has studied the influence of specific dietary deficiencies on the tumour-inhibiting activity of various compounds on sarcoma 180 in mice. By maintaining tumour-bearing mice on a diet deficient in certain amino acids, Prof. Skipper obtained consistently and significantly less tumour growth than in mice maintained on a nutritionally "complete" diet; whereas deficiency of certain other amino acids did not have this effect. Furthermore, depriving the host itself of essential amino acids led to a rapid loss in body weight of the host, so that there was no evidence of selective inhibition of the tumour cells under the conditions employed. It was suggested in the course of general discussion that although the real difference in cell metabolism of normal and cancer tissue is not known, such a difference must exist, so that depriving the tissue of metabolites essential for tumour growth may become a feasible line of attack. Inhibition of purine biosynthesis by azaserine and DON (6-diazo-5-oxo-L-norleucine) was related by Prof. J. M. Buchanan (Cambridge, Mass.) to the diazo groups of these two compounds. These interesting compounds inhibit growth in various systems and in a number of experimental tumours, as described by Dr H. Christine Reilly (New York); but so far neither shows promise as a clinical chemotherapeutic agent if administered alone, since they are highly toxic in the doses necessary for tumour inhibition. This does not mean that an effective combination therapy may not yet be discovered, bearing in mind the excellent results that have been obtained by the use of combination therapy in combating some of the infectious diseases.

Compounds with proved or potential anti-tumour properties were discussed by Dr J. A. Stock, who presented the results of a large group of research workers at the Chester Beatty Research Institute. This investigation was based on attaching a nitrogen mustard group to a natural amino acid as a "carrier". Clinical aspects of some of these compounds were described by Dr Eve Wiltshaw, and by Dr Natalia Perevodchikova, who reported on results obtained with her colleagues at the Academy of Medical Sciences of the U.S.S.R.

Actinomycin, a peptide-containing antibiotic, was first isolated in 1940 from a culture of the soil microbe, *Streptomyces antibioticus*. A number of actinomycins have since been found. Although they are powerful antibiotics, their high toxicity precluded their use as clinical agents; but recently they have been found to have a cytostatic effect. The chemistry of these compounds was discussed by Prof. A. W. Johnson (Nottingham) and clinical and biological studies by Prof. S. Farber (Boston). One of the properties of actinomycin, discovered by Prof. Farber and his colleagues, is that of potentiation of radiation effects against previously radio-insensitive tumours. Determination of the chemical structure of another peptide-containing antibiotic, etamycin, also isolated from cultures of *Streptomyces* species, was illustrated by Prof. J. C. Sheehan (Cambridge, Mass.). Prof. M. Brenner (Basel) described some hitherto

* The proceedings of the above symposium will be published this month under the following title: "Ciba Foundation Symposium on Amino Acids and Peptides with Antimetabolic Activity", London, Churchill, 1958.

unknown chemical properties of peptides, and stated that rearrangement on the basis of an aminoacyl insertion reaction is a special feature of the chemistry of polyamides, and has a bearing on the synthesis, isomerisation, and possibly degradation of peptide chains. The first synthesis of a natural cyclic polypeptide, gramicidin S, recently accomplished by Dr R. Schwyzer (Basel), illustrated the method of synthesis of cyclic polypeptides using activated esters. Prof. H. N. Rydon (Exeter) spoke of disulphide cross-linking in cysteine peptides, and Dr Abraham (Oxford) described the structure and function of the sulphur-containing peptides, bacitracin A and the Cephalosporins. The compounds studied by Dr Abraham have a high chemical reactivity and appear to interfere with the maintenance of bacterial cell walls. Further chemical studies of the bacitracins were reported by Prof. L. C. Craig (New York), and the chemistry and biosynthesis of the mould product mycelianamide was discussed by Prof. Birch.

The search for an effective anti-tumour agent which would not damage the normal host tissue is further complicated by the problem of drug resistance. In pointing out that this resistance appears similar to drug resistance in micro-organisms, Prof. Farber suggested that the answer might be to attempt to convert temporary improvement, as is produced, for instance, by the folic acid antagonists in acute leukaemia, into permanent cures. Prof. Sheehan proposed, as a possible new approach, to get away completely from the idea of toxic agents, and concentrate instead on providing the tissue with some hitherto unknown non-toxic agent which somehow would support the normal cells and ultimately enable the tumour to become a part of the normal tissue. Prof. Bergel re-emphasised these points, and said that one outcome of this symposium was that attention would be focused on developing more selective and less toxic substances; and that it is important to think not only in terms of destruction of the tumour itself but also in terms of back-mutating the tumour, of keeping it under control and living with it.

Astronautics in Amsterdam

G. V. E. THOMPSON B.Sc. (Eng.) A.R.C.S.
Editor, the Journal of the British Interplanetary Society

Had the launching of the first American lunar probe on August 17 been successful it would have added greatly to the world-wide interest shown in the Ninth International Astronautical Congress, held in Amsterdam University on August 25–31, 1958. Even the Russian announcement during the Congress that two dogs had returned unscathed from a rocket trip to a height of 250 miles was a poor substitute. Indeed, Russian scientists at Amsterdam remarked that this feat had received more publicity than it deserved. They regarded it as merely yet another successful biological experiment, and considered that only the safe recovery of a manned satellite would constitute a notable advance in the development of astronautics.

Although the lunar probe was a failure, it was an American achievement which provided the greatest attraction at the Congress. Dr Wernher von Braun, formerly in charge of the development of the V2 rocket at Peenemünde and now Director of the Development Operations Division of the U.S. Army Ballistic Missile Agency at Redstone Arsenal, Alabama, presented a paper on the *Explorer* satellites. The interest in his paper was heightened by the fact that its delivery was postponed some four or five times during the week. This was because, soon after the opening of the Congress, Dr von Braun strained a back muscle in bending over to pick up a piece of paper dropped by a lady and was immediately ordered to bed as a suspected "slipped disc" casualty. When he eventually spoke at the final session of the lecture programme, he revealed the reason for the failure of *Explorer V*. At a height of 58 miles above the earth's surface the engine of *Explorer*'s first stage (a modified *Redstone* missile) is cut off, and five seconds later six spring-loaded explosive bolts are ignited to allow the first stage to separate. The five seconds' delay is intended to enable the first-stage thrust to decay. While the thrust drops rapidly to a fraction of its original level, further decay then proceeds slowly. This is caused by expansion of gas from the combustion chamber (and of any propellent trapped between the cut-off valves and the combustion chamber) into the near-vacuum outside the engine. Separation of the first stage from the remainder of the vehicle is only brought about by the comparatively weak forces of the springs, and both parts are then allowed to coast through a vacuum trajectory nearly up to its apex before the second-stage engine is switched on. The five seconds' delay should thus prevent the weak residual thrust of the first-stage engine from driving the booster into the rear of the main vehicle. In the case of *Explorer V*, collision did occur and the vehicle became disorientated.

Dr von Braun also described the experiments which had been made with the satellites, the most important being that to determine the intensity of radiation in outer space. Data from the successful satellites (*Explorers I, III,* and *IV*) revealed the presence of a belt of high-intensity radiation, much stronger than had previously been expected. The paper also included a chart showing the times of day throughout the year at which a firing was permissible from Cape Canaveral from a point of view of temperature. If launched at unsuitable times, the satellite spends too long in sunlight as it travels round the Earth. Even without the additional heat stemming from the electrical equipment, temperatures within the satellite rise above the value acceptable for the equipment it contains. Actually measured temperatures agree reasonably well with those predicted.

Details of their rocket vehicles were not given by the Russian speakers but Prof. L. I. Sedov reported the results of observations of *Sputniks I–III*. In general, the data obtained were in agreement with those from American observations, but the latter extended to much greater altitudes (results of observations of *Sputniks I* and *II* made by the Royal Aircraft Establishment have recently been published in the *Journal of the British Interplanetary Society*). Prof. K. F. Ogorodnikov outlined the visual and photographic methods of observing artificial satellites at stations in the U.S.S.R.

In all, about eighty scientific papers were read at the Congress, and nearly twenty other contributions were made at an associated Colloquium on Space Law held in the Rolzaal (Hall of Knights), Binnenhof (Houses of Parlia-

ment), The Hague. This represents an increase of well over 100% on the number of papers read at last year's Congress at Barcelona, and necessitated the holding of parallel sessions, much to the disappointment of many participants. One series of sessions was devoted to the problems of propulsion systems and propellents, and the main emphasis here appeared to be on more advanced methods of propulsion: nuclear-powered vehicles, ramjet boosters, ion and photon rockets, and so forth. Dr L. R. Shepherd (of AERE, Harwell) considered the various possible electric propulsion systems for space-flight and favoured the use of a closed-cycle plasma generator coupled to a magnetic plasma accelerator.

Of the papers on subjects other than propulsion, the most notable was that of Prof. Fred Singer of the University of Maryland, who over the past few years has been studying the trapping and storing of radiation by the Earth's magnetic field, mainly in connexion with a new theory of magnetic storms and aurorae. Of all the hypothetical mechanisms examined, only one was found to be theoretically possible. In this, neutrons are released by the action of primary cosmic rays on gas nuclei at a height of 20–25 km. Being uncharged particles, the neutrons are unaffected by the Earth's magnetic field and travel in straight lines. A small proportion will travel in an approximately upward direction. As free neutrons are radioactive, a certain fraction of them changes into protons initially moving in the same direction. Prof. Singer has shown that where the direction of motion is suitable, these protons begin to spiral around the lines of force of the magnetic field, and are "trapped", because the pinching together of the lines of force near the Magnetic Pole causes them to be reflected back. They thus spiral backwards and forwards from Pole to Pole almost indefinitely. Calculations show that only a minute number of protons are injected into such an orbit: 1 particle/cu. cm. of space every 30 million years. But the lifetime of these particles is so long that over the period of the existence of the atmosphere a considerable equilibrium concentration has been built up. Prof. Singer has also deduced that a radiation belt exists from about 250 to 40,000 miles above the Earth's surface, with maximum intensity at about 6000 miles up. Data from *Explorers I* and *III* did not quite agree with these predictions, but the more accurate results from *Explorer IV* agreed quite well. However, the "vertical section" data from a lunar probe would give a much better check on the accuracy of the theory. More direct corroboration could be obtained by sending a small particle accelerator aloft in a satellite and injecting electrons to produce an artificial radiation belt.

If this theory is correct, the radiation above 250 miles altitude is lethal and manned satellite experiments would have to be carried out at lesser heights. Effective shields would be too heavy to be employed, but shadow or magnetic methods of shielding might be practical. However, manned trips into space would be possible near the Magnetic Poles, where the radiation belt is absent. Prof. Singer's most radical suggestion is that the radiation belt might be rapidly swept away by use of artificial satellites to absorb the radiation. The cross-sectional area of the channel would be quite large in comparison with the size of the satellite and the radiation would only build up again at a very slow rate because the injection rate is so small.

There were several interesting contributions in the field of space medicine. Dr von Beckh of Holloman Air Force Base showed a film in which subjects were kept awake for 48 hours, given a heavy meal and then allowed to sleep while flying. The plane was flown in a parabola to produce the weightless condition and the subject suddenly awakened. This produced a much greater effect than when the subject was already awake when the weightless condition was produced. A feeling that one's arms and legs were floating away from the trunk was experienced and the powers of co-ordinating the movement of the limbs were greatly reduced.

Andrew G. Haley was re-elected President of the International Astronautical Federation and it was agreed that the next Congress should be held in London in September 1959. This meeting had previously been scheduled to take place in Moscow, but the Russian delegation had to withdraw their offer to act as hosts because of the shortage of hotel accommodation in Moscow, though they hope to be able to organise the 1962 Congress. If the number of participants and papers presented continues to increase (many American firms regarded the congresses as a useful means of making European contacts with a view to placing research contracts abroad), the British Interplanetary Society will have a hard task to organise another London Congress (the second Congress was held here in 1951) in only a year, and it is to be hoped that both governmental and industrial assistance will be forthcoming. In Holland, the Congress was considered of sufficient importance for the delegates to be given official receptions by the cities of Amsterdam and Rotterdam as well as permitted the use of the parliament buildings.

Other Meeting

International IUC Assembly

Experts from forty countries convened in September at Athens to discuss plans for the most profitable use of the world's supply of soil and water. This was the Seventh General Assembly of the International Union for the Conservation of Nature and Natural Resources (IUC), an organisation with headquarters in Brussels.

There were more than 300 experts present to consider prospects for solving some of the difficulties, through education, in a way that would serve all interests. The discussions concerned the protection of soils and the improvement of productivity by vegetation, dams and reservoirs, and by ecological planning.

The water problem is largely one of distribution. Participants at the Assembly considered practical means for getting the water where it is most needed without upsetting other interests. They also considered rates of run-off, loss from evaporation, and effects of water diversions on expendable resources such as fish. Also under study were plans for the preservation of threatened species of animals and plants.

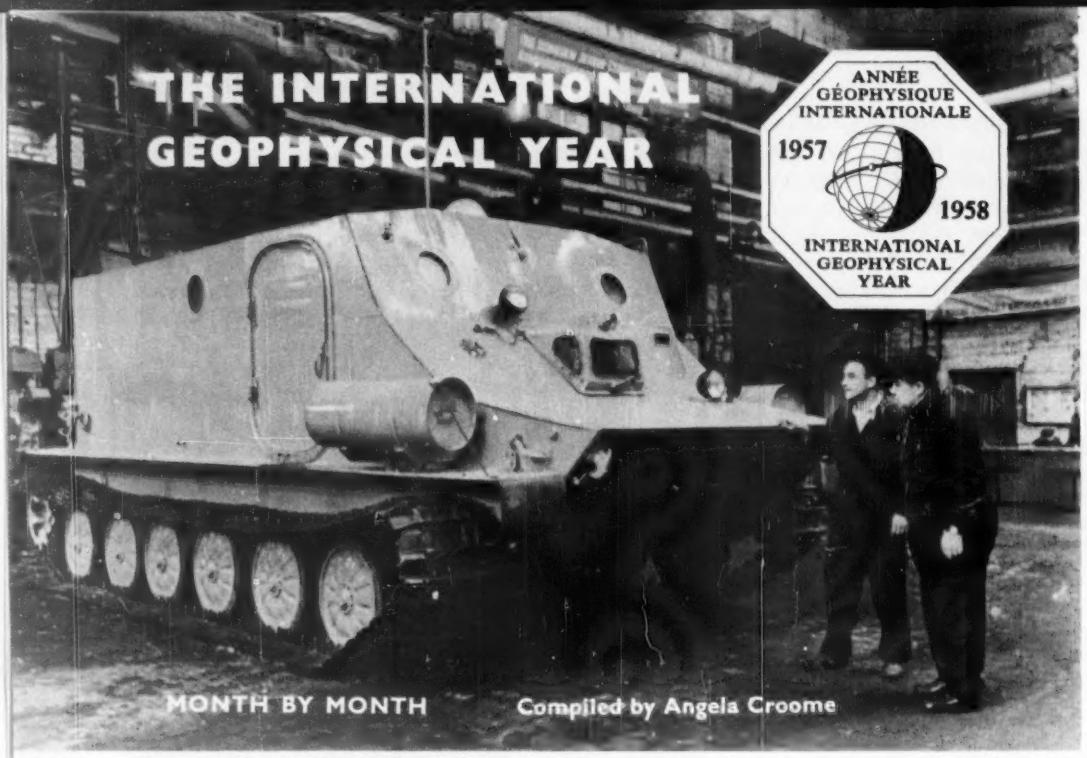


FIG. 1.
The Kirov Plant in Leningrad manufactures the specially designed *Penguin* snow vehicle for the Soviet Antarctic expedition. The tractor has a streamlined body, two wide tracks, and a high cross-country performance, easily negotiating loose snow. A hermetically sealed body enables it to stay afloat in water.
Photograph shows engineer P. Ilyazhevsky (*right*) and driver A. Andreev examining a machine ready for shipment.
Readers might like to be reminded of the correspondence in DISCOVERY dealing with large "Tank Laboratories" for use in the Antarctic which was published in DISCOVERY, 1957, vol. 18, p. 311.

Antarctic Plans include 3700-mile Journey

The Russians announced at the end of September a change in their projected plan for a trans-Antarctic expedition to be launched this season. At the SCAR (Special Committee for Antarctic Research) meeting that took place in Moscow immediately after the main IGY conference in August they disclosed their intention to cross Antarctica from Mirny to the Bellinghausen Sea during their future operations, a route considerably longer and lying at right angles to that pioneered by Fuchs's crossing party last year.

The new plan is, if anything, even more ambitious. The expedition will carry out the longest surface journey ever attempted in the Antarctic and will travel over the least reconnoitred and most hostile section of the area. The principal part of the journey (which will start from Mirny shortly) forms a huge triangle with 600-mile sides and a pole at each of its points. The poles involved are the Geomagnetic Pole, 78° 27′ S., 106° 52′ E., the Inaccessibility Pole, 82° S., 50° E., and the Geographic Pole, 90° S. The distance involved is about 3700 miles. Though full details of the scientific programme have not yet been released, a thorough seismic investigation is to be carried out along the route and this will undoubtedly clear up any remaining doubts as to whether Antarctica is a continent or an archipelago of islands supporting an overlying ice-cap. P. A. Shumsky's report to the Moscow meeting made clear that the Russian expedition is in no doubt now about the status of eastern Antarctica, which has already been rather thoroughly studied by their scientists: their finding is that eastern Antarctica is not a group of islands but a continent which has subsided under the weight of the ice-sheet.

At least two seasons' work is envisaged for completion of this great new project. The establishing of two more stations is involved; one of these is, of course, the Inaccessibility Pole station, Sovietskaya, which has yet to be put in. It will presumably be established this season and will probably be a secondary station manned only in the summer. The other station, to be called Lazarev after a distinguished Russian sailor of the 19th century, is to be placed on Antarctica's Atlantic coast, between the current Belgian and Norwegian bases, and will be the terminal point of the 3700-mile journey. This is also to be put in this season, by a party conveyed there and supported by the 12,500-ton polar ship *Lena*.

The strategy for the expedition appears as follows: it will begin almost at once from the coast at Mirny, the Russians' principal station and supply point in the Antarctic. The first stretch of the journey will be completed when the party reaches Vostok, the Geomagnetic Pole station, some time early in the New Year. In the Antarctic spring of 1959 (October) the expedition will move off for the Inaccessibility Pole, probably the most inhospitable place in the world. It is not clear whether the same party will then strike back south-east for the Geographic Pole; it seems more likely that the expedition will be divided in two parts at Vostok—one to make for Inaccessibility, the other to negotiate the sector on to the Geographic Pole, and from there to Inaccessibility. From Vostok on, the hinterland is entirely unexplored. A few aeroplane flights have passed in the vicinity but that is all. It will be of outstanding interest to learn what the area contains; it is about the size of Spain and all of it is thought to lie above 10,000 ft. like Tibet.

One of the greatest foreseeable obstacles that the expedition will have to face is that presented by the large areas of soft, powdery snow where even tracked vehicles are liable to sink as deep as the height of a man. To counter such conditions the Russians have designed two new snow tractors (a heavy one for haulage, the other a light reconnaissance vehicle, see DISCOVERY, 1957, vol. 18, No. 12, p. 529). These have caterpillar tracks each a yard wide and are said to exert no more pressure at any point of contact than that made by a human foot. They are also supercharged to give additional engine power at high altitude.

The original Russian plan, for an Antarctic crossing from coast to coast, at right angles to Fuchs's route, envisaged a new station at the terminal point on the Bellinghausen Sea. Though a crossing is no longer in view, the Bellinghausen station and its scientific programme is still to be established. This is scheduled for the coming season.

$20,000,000 of Air-mapping Equipment

At Moscow the Russians also asked for international co-operation in the mapping of the whole of Antarctica on a large scale. They are to tackle a substantial section themselves, using new four-engined aircraft specially equipped for the job with recently developed aerial-survey

cameras of great refinement. One observer estimates that about $20 million worth of this new equipment has been earmarked for the project. No doubt the inland expeditionary party will have its part in providing ground fixes for the aerial photogrammetry.

During the SCAR meeting a working group to study the proposal for a new and large-scale map of Antarctica was set up. This has for some time been a project dear to the heart of Col. G. Laclavère, a leading CSAGI member and convener of the Antarctic IGY committee who is now president of SCAR. The Russian aerial survey will presumably make a substantial contribution to this.

American effort and scientific manpower is to be considerably redeployed this season. The Wilkes Station with its installations will soon be transferred to the Australian Antarctic research expedition on a permanent basis. Press reports reveal that the Australians may also take over the operation of the Antarctic Weather Central (run for the past two years by the U.S.) when the Little America Station is closed later this season. If so, the traffic centre and synoptic analyses will be carried out in Australia and not in the Antarctic as before. Reception should be much better there.

Ellsworth Station (on the Weddell Sea) will not be continued under U.S. direction much beyond the New Year. The Argentine will take over this station from the Americans.

Before Little America is closed it will provide the starting point for another major traverse to be led by Dr Albert Crary, senior scientist of the U.S. expedition. Last year he completed a 1500-miles triangular march on the Ross Ice-shelf which yielded important results. This year's projected route will cross the Ice-shelf from Little America to the foot of the Skelton Glacier that leads up into the mountains that edge Victoria Land. The traverse party will penetrate into Victoria Land via the route up the Skelton pioneered by the New Zealand team of the British Trans-Antarctic expedition. The total traverse is expected to cover a distance of at least 1000 miles. The principal measurements will be concerned with ice-thickness and structure.

Great Britain has decided to continue the Halley Bay Station's work indefinitely. This was reported to the SCAR meeting in August. After January 1, 1959, however, the organisation and supply of the station will pass to the Falkland Islands Dependencies Survey. The Royal Society will, however, continue to advise on the scientific programme.

The SCAR meeting in Moscow must be reckoned a considerable success. Though at the beginning there was by no means unanimity of view on all the business, by the end of the meeting all differences had been substantially resolved.

Further Advances on a Broad Front

A third astronomy was presented to the Moscow meeting, in the satellite and rocket symposium, by Dr Herbert Friedman of the U.S. Naval Research Laboratory who has taken part in this research. The study of ultra-violet light from the galaxy has proved feasible from *Aerobee* rockets during the short period they are flying above the Earth's atmosphere. It has been found that strong sources of ultra-violet in the night sky of the northern hemisphere correlate neither with the sources of visible light (naked-eye stars) nor with the so-called radio stars. It therefore seems that ultra-violet or rocket astronomy gives a further dimension to the universe; that it provides an additional source of knowledge which may prove as fruitful to astronomical studies as the radio telescope. The new astronomy, however, is a very difficult and exceedingly expensive business, but the results gained in little more than a year's work have shown it to be thoroughly worth while.

Far ultra-violet radiation of galactic origin was first observed during a rocket flight in November 1955, but the optical resolution of the detectors was not sharp enough to permit any detailed mapping of the sources. Much higher resolution was achieved in a flight on the night of March 28, last year. In the wavelength interval between 1225 Å and 1350 Å numerous extended sources of gaseous nebulae were mapped with a resolution of 3°.

The technique is as follows: Photon counters are mounted against a casting, the outer surface of which conforms to the cylindrical shape of the rocket. Each photon counter looks forward through a honeycomb of channels built up from fine tubings—hypodermic needles are in fact used. The view through the needles is restricted to 3°. Four photon counters are mounted side by side on the casting, but the viewing channels are directed to 105°, 90°, 82·5°, and 75° to the long axis of the rocket. As the rocket rolls the tubes scan in a 30° fan, with each individual tube viewing a strip of the sky 3° wide only. The roll period is 16 seconds and the flight of the rocket resembles that of an arrow which attains a horizontal attitude just before the peak of the trajectory. The combined spin and precessional motions permit a large area of the sky to be scanned. Information from each counter is telemetered continuously and recorded on an oscillograph.

The data recorded permits the plotting of contour maps of intensities in the wavelength interval 1225 Å to 1350 Å Fig. 2 shows such a map of the sky in equatorial co-ordinates.

The nebulosities around α Virginis and Orion have been scanned so many times that detailed contour maps have been drawn. The nebula around α Virginis is over 20° in diameter with an average surface brightness of 5×10^{-4} erg/cm.$^{-2}$/sec^{-1}. There is no visible nebulosity in this region.

The Orion nebulosity is very extensive and is not restricted to the H II regions observed in visible light. The ultra-violet radiation correlates roughly with the distribution of interstellar material in Orion and has a surface brightness comparable to that of the discrete emission nebulosities in H α. The total energy radiated in the narrow spectral band 1225–1350 Å is therefore very large.

Although most of the observed radiation comes from regions near the galactic

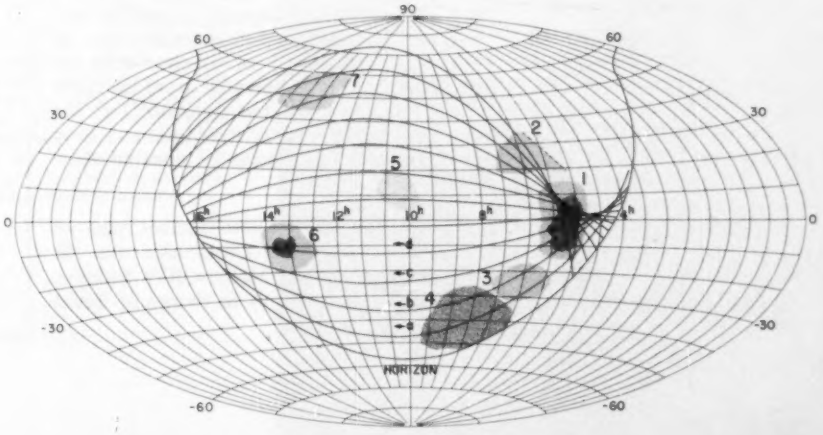


FIG. 2.
A 1300 Å Map of the Sky derived from the data collected by Aerobee 31. The map shows equatorial co-ordinates of the sky. Successive scans of a single photon-counter are labelled *a*, *b*, *c*, *d*, etc. The degree of shading indicates relative intensities of ultra-violet radiation. Seven strong emission nebulosities appear here in the regions of Orion (1), Taurus (2), Canis Major (3), Puppis-Vela (4), Leo (5), Virgo (Spica) (6), Ursa Major (7).

plane there is definite indication of sources at high galactic latitudes. Future experiments are planned to cover additional wavelength bands centred at 1500 Å and at 1150 Å. Higher resolution can be obtained with simple mirror telescopes.

So far data has only been obtained for the northern sky since most of the *Aerobee* flights have taken place from Fort Churchill, Canada. Immediately after the presentation of this paper at the Moscow symposium Australian astronomers present offered facilities for rocket flights to observe ultra-violet radiation in the night sky of the southern hemisphere.

The last of *Sputniks I* and *II*

Orbital considerations of artificial earth satellites occupied the attention of the symposium on rockets and satellites at the Moscow meeting for a very considerable part of the four-day deliberations. The upshot of this was that the orbital calculations initiated by Mr D. G. King-Hele of the Royal Aircraft Establishment, Farnborough, and the results derived from these were endorsed by all participants on almost all disputed points.

We here give the principal conclusions of these discussions.

1. **The descent of *Sputnik I* rocket** (1957 α 2). Analysis of additional observations that have become available, taken in conjunction with orbital theory, show that the rocket survived into the first hour of December 1, 1957, and most probably did not burn up completely in the atmosphere. It is quite certain that it did not descend over Alaska at the end of revolution 878; a good observation of it was obtained at 0018 hours December 1 off California on revolution 879. On the contrary there is good evidence for believing that it almost completed revolution 879 and that the remains of the rocket probably struck the Earth's surface somewhere in Siberia. There is a certain irony about this disclosure since it may be remembered that Mr Kruschev asked for the rocket remains presumed to have been scattered over Alaska to be returned by the U.S. Government.

2. **The descent of *Sputnik II*** (1957 β). Farnborough work as presented to the conference was able to show that this object (unseparated satellite and carrier-rocket) survived longer than had previously been thought and most probably did not burn up completely in the atmosphere either. The last minutes of this body were highly spectacular. They were at night; this has enabled the plotting of events in some detail. Jodrell Bank picked it up by radar late on the night of Sunday, April 13; it was travelling a bare 80 miles up by this time and no radar "saw" it again. It was picked up more than a revolution later, however, visually, by two Moonwatch teams near New York, *although it was flying so low now as to be shaded from the Sun's rays by the Earth itself*.

It had become incandescent due to the heat generated by friction with the atmosphere. It passed out to sea travelling SSW over the Caribbean. The account of its passage has been pieced together from the witness of twelve British ships plying in the Caribbean or Atlantic at the time and from two valuable observations made from Trinidad. The observations agree well. During the ten minutes taken between New York and the point it crossed above the South American coast it sprouted a tail estimated at between 50 and 90 miles long and described as "alive with sparks like the sparks thrown off a grinder's wheel". The sparks were often seen to fall away from the tail and then soon ceased to glow. The satellite itself seems to have taken on almost every colour of the spectrum during these last minutes of its descent and has been reported as orange, yellow, greenish-blue and red, silver, yellowish-white, blue and red, red and white, green and red, red, orange and white, and a "rather sulky crimson" among others. Its brightness as it passed low above the southern Caribbean appears to have been roughly stellar magnitude −5 at a distance of 100 nautical miles. Between New York and the vicinity of Trinidad it is thought to have sunk from about 70 to about 40 nautical miles high. It is estimated to have finally plunged to earth somewhere between this area and the mouth of the Amazon, at about two o'clock in the morning of April 14 (see Fig. 5).

Sputnik II has proved interesting in other ways. For instance, a study carried out by Farnborough scientists of the *Sputnik*'s rate of change of period, using some 400 observations, shows a considerable departure between the observed values and the theoretical at certain stages in the satellite's lifetime. It is suggested that these fluctuations were caused by day-to-day fluctuations in atmospheric properties at perigee—either due to changes in the number of particles per unit volume or in their electrical state. An oscillation period of about twenty-five days is faintly discernible from the curve plotted and this has suggested that the tide-raising force of the Moon may have some part in producing the observed effect.

Erratum

We regret that in our October issue we stated that Prof. Lebedinsky was the leader of the big Moscow IGY Meeting. Prof. Lebedinsky is in charge of Soviet auroral research.

TIMETABLE OF RECENT IGY ROCKET EVENTS

Aug. 17: First American "lunar probe" launched from Cape Canaveral by U.S. Air Force. A failure due to the second stage firing prematurely, after 77 minutes' total flight time and at an altitude of 50,000 ft. Object: to circle the Moon and scan the hidden face by photoelectric means. Vehicle: *Thor* + *Vanguard* second- and third-stage (the Aerojet *General*) with eight small boost rockets added.

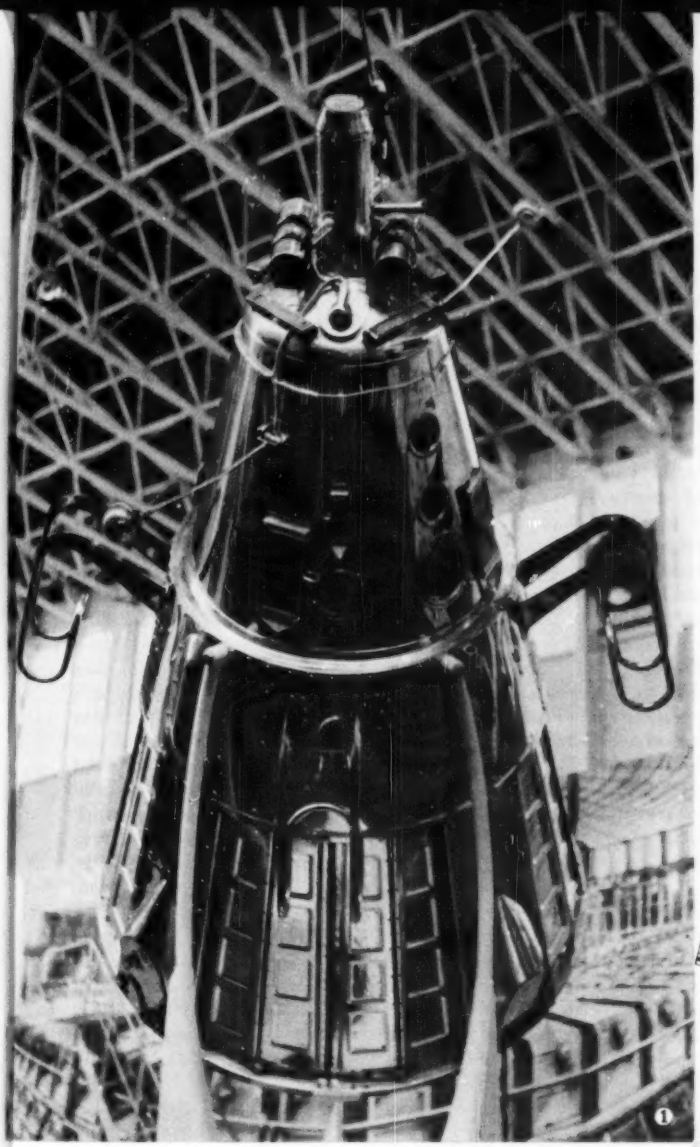
Aug. 24: *Explorer V* failed to go into orbit.

Aug. 27: Soviet single-stage "geophysical" rocket carried two dogs (and other experiments) to a height of 280 miles; they returned unharmed to Earth in their pressurised cabin by means of elaborate series of braking devices and a large parachute. This is the record height that a mammal has returned from.

Sept. 22: Fourth British *Skylark* rocket experiment fired at Woomera. Height reached 95 miles.

The U.S. Navy satellite project *Vanguard* has fared as follows since the fourth and last test vehicle was fired and entered orbit on March 18. On April 28, May 28, September 17, *Vanguards* carrying the full 20¼-in. 21-lb. instrumented sphere were launched and failed to achieve orbit. On September 27 the fifth full-scale experiment was launched and all three stages of the rocket functioned perfectly but no confirmation that this *Vanguard* is orbiting has yet been received.

Oct. 11: Second "lunar probe" launched and during its 44 hours of life reached a third of the way to the Moon, 79,212 miles. Not only was it remarkably nearly successful—an error of 3½° and loss of about 1000 m.p.h. on launching appear to have been jointly responsible for relative failure—but it travelled 20 times higher than any previous object and telemetered data on conditions up to this region in space. Vehicle: as before. Experiments: ambient radiation, magnetic measurements, micrometeorites, internal temperature.



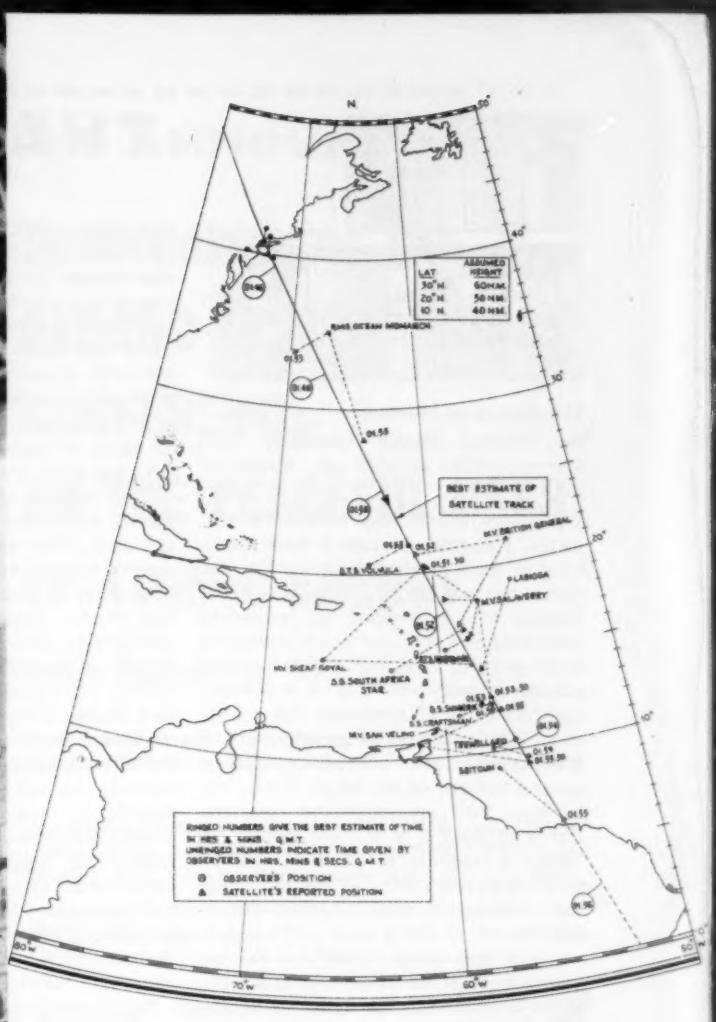
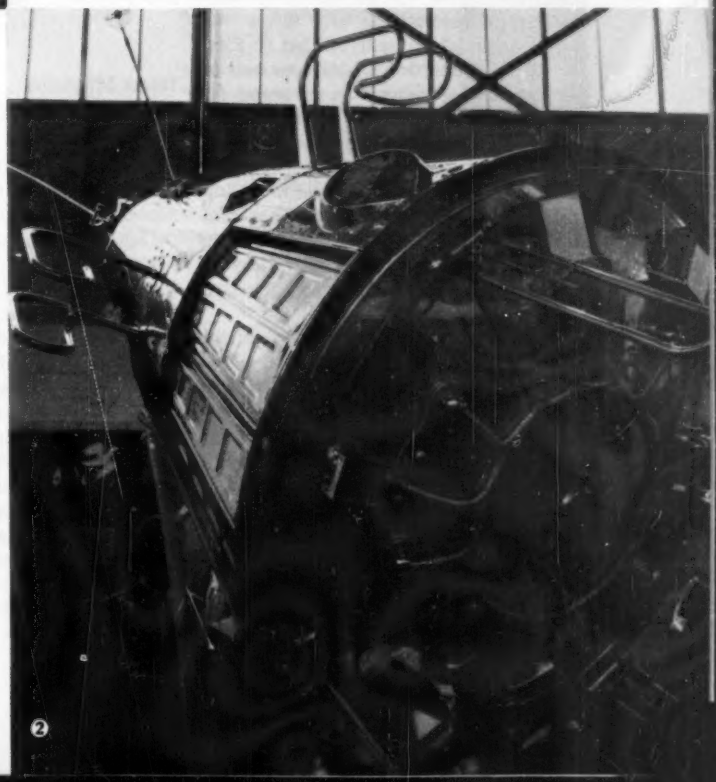
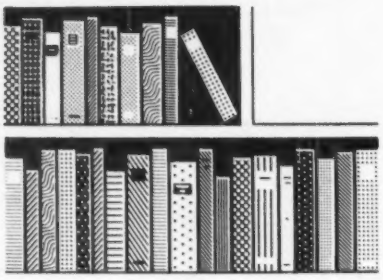

BEST ESTIMATE OF SATELLITE TRACK
ROUND NUMBERS GIVE THE BEST ESTIMATE OF TIME IN HRS. & MINS. G.M.T.
UNROUNDED NUMBERS INDICATE TIME GIVEN BY OBSERVERS IN HRS. MINS & SECS. G.M.T.
OBSERVER'S POSITION
SATELLITE'S REPORTED POSITION

FIG. 5. The last minutes of *Sputnik II*, April 14, 1958.

FIGS. 3 and 4. Two contrasted views of the *Sputnik* nose-cone identical with that of *Sputnik III* currently in orbit, on display at the "Atoms for Peace" Conference at Geneva. In Fig. 3 a number of instruments can be identified, located in the skin of the forward section and in the immediate vicinity of the nose-probe (a magnetometer). On either side the probe, a photomultiplier for registering solar corpuscular radiation; near them facing forward, four equally spaced collecting plates for the solar batteries. Two ball-cock like objects projecting at right angles are ion-traps. The two grills lower down are electrostatic fluxmeters. Probes for measuring ionisation and magnetism and the mass-spectrophotometer tube are seen just projecting from the skin near by. The three cosmic-ray instruments are not visible. Fig. 4 shows the four unfolded radio antennae projecting out behind the *Sputnik* after separation from the rocket, as here. The two smaller "boxes" mounted on the bottom of the nose-cone are for measuring micrometeorite impacts.



THE BOOKSHELF



The Springs of Adventure

By Wilfred Noyce (*London, John Murray, 1958, xii+240 pp., illustrated, 18s.*)

I find this a difficult book to review briefly, partly, I suspect, because I have speculated so much on the subject myself. The author has selected an intriguing title and fastened to it a rambling but fascinating discussion of a problem which (according to the point of view from which it is considered) is easily answered or is virtually unsolvable: what motivates the adventurer? The answer to the general problem Wilfred Noyce gives himself in two places towards the end of the book. On p. 181, he says, "We are inquisitive creatures, that is all there is to it," and farther on, "What of curiosity, for instance? Have I plumbed its real depths, its deepest springs from which, in a sense, all other motives flow?"

I have little doubt myself that the real motive force of the adventurer as a genus is the restlessness that comes from the sublimation of the primitive instinct which originated back far beyond man, in the struggle for survival in a competitive world. Man, the tool-maker and tool-user, has so far outrun his competitors and has put himself on such terms with the world in which he lives, that an ever-increasing proportion of his time can be applied to other things than the search for clothing, food, and shelter. Unfortunately much of his surplus energy and drive has gone into devising better means of destroying the lesser beasts and his fellow men. Only a little of this energy has gone into adventure, sometimes for its own sake, but more often for a variety of reasons that are pinpointed and dissected in the chapters of this book.

When it comes to an assessment of the motives of individual adventurers, the author tackles a really difficult task. To begin with, much of the evidence is suspect, for the man who can set down his own particular conscious "springs of adventure" without bias or partiality is the exception and not the rule. Such a personal evaluation may, for example, be the result of a need to have "a point of view"—orthodox or unorthodox according to the nature of the particular individual concerned. Unlike Noyce, I feel that the desire for fame is very often a motivational factor. Assessment of the importance of the desire for gain as a motive is complicated by the fact that any leader of a major expedition is compelled willy-nilly to be a beggar. The adventurer who looks for fortune from his venture, at least in Polar exploration, has less than his share of brains; if he gets it he will have had more than his share of luck.

"The springs of adventure" are obscurely embedded in the very fibre of mankind. They may be released in the most haphazard manner: by boredom or frustration, as when, in Bristol, the writer said on first hearing of the chance of joining Shackleton, "I'd go anywhere to get out of this damned place"; or by the frankly reprehensible, as when Erik the Red, finding himself incapable of refraining from homicide, was exiled to colonise the West Greenland coast. They may result in pure self-indulgence; in scientific inquiry; in missionary enterprise; in a hundred combinations of these and other gains. The "springs" are latent in any normal man and if they cannot find an outlet in mountaineering, in exploration, in sailing, or in crossing oceans on rafts, they may come out in other ways, possibly even more beneficial to mankind.

Mr Noyce has done his writing as he has thought his problem through. The value of the book is that it will cause the adventurer himself to think; it may even cause some of us to re-assess our motives and perchance come nearer to the truth.

R. E. PRIESTLEY

Insect Migration

By C. B. Williams (*London, Collins, 1958, xiii+235pp., 30s.*)

The previous volumes in the "New Naturalist" series have been remarkably successful in their objective of combining "a high standard of accuracy" with "the results of modern scientific research" in such a way as to be comprehensible to "the general reader", but no previous author has done this more successfully than has Dr C. B. Williams. Without making any concessions to popularity, he has produced a book on a difficult subject which can be read with interest and profit by those without any specialised training, though at the same time professional entomologists can learn a great deal from these pages.

Although, particularly in recent years, there have been many who have studied the problems of insect migration, it will be generally agreed that Dr Williams has been the pioneer in all recent studies, and the man who has done more than anyone else to describe and establish these phenomena. What a mass of data he has compiled, edited, and presented here in such a way that those who are unfamiliar with the subject may be deceived into underestimating the effort and skill that have gone into the presentation. I do not think that it would be untrue to say that every major migration of insects which has ever been investigated has been considered in the preparation of this book. Those who have perhaps been discouraged by an unsuccessful attempt to understand another facet of Dr Williams's work, that dealing with the mathematical analysis of numbers relating to insect populations and their distribution, may hesitate to tackle this book, particularly as one reviewer has described it consisting "so much of statistics". I can assure any potential reader who is as non-mathematically minded as the reviewer that this work should present no difficulties on that score.

The text is divided into four sections. The first is a brief historical introduction, and is followed by an account of the evidence that insects do in fact migrate. More than half this evidence relates to butterflies and moths, locusts are dealt with perhaps more briefly than their economic importance warrants, and some records for dragonflies, beetles, flies, and leaf-hoppers are included.

The third section, which comprises 96 pages, is called "The Problems". Here Dr Williams deals with the nature of migratory flights, and discusses the factors which may be responsible for their initiation and orientation. He shows that in fact in an increasing number of cases insects do not simply immigrate into new territories, but that return migrations at other seasons (often of much smaller numbers of individuals) also take place. Some suggestive facts relating changes in the physiology of particular insects to migration are included. The fourth short section explains the methods used in studying insect movements.

The publishers, in their advance notices of this book, compared it to a detective story and cast Dr Williams in the role of the master-sleuth. I do not think that this was a happy comparison. The essential feature of a detective story is that in the last chapter every question is neatly solved. Dr Williams would be the last person to claim that he has gone anything like so far. He has (to follow the publishers' analogy) established that

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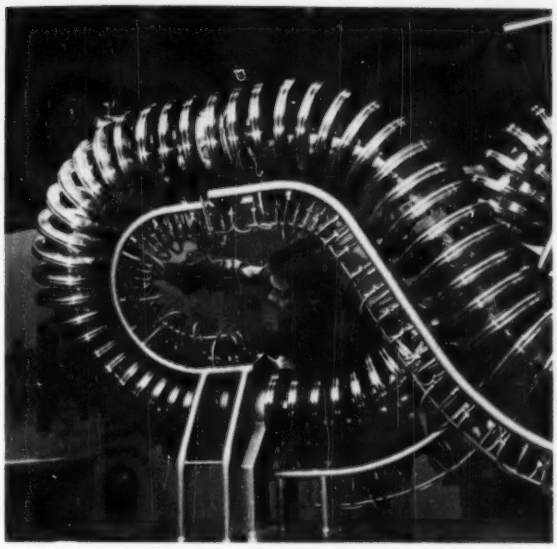
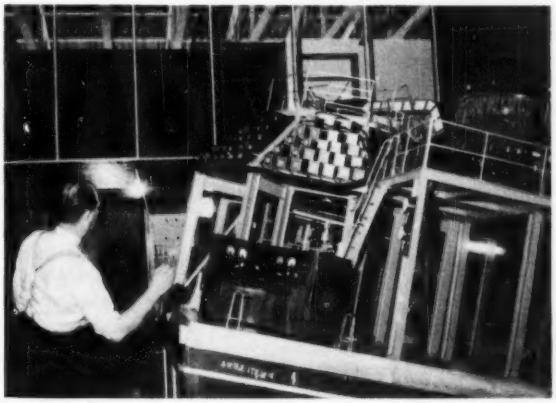
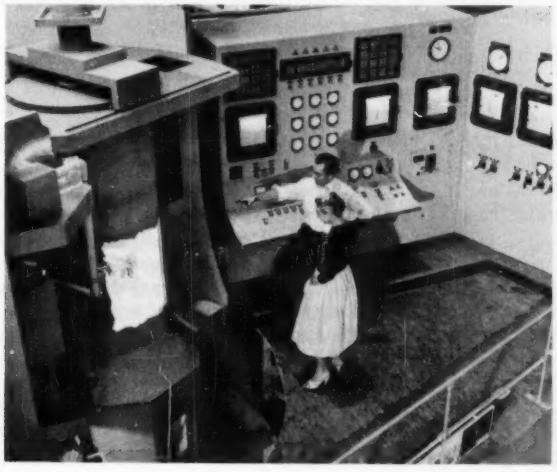


Stellarator developed for producing controlled thermonuclear reaction. The exhibit demonstrates how to confine deuterium gas in tube. *(U.S. exhibit, "Atoms For Peace" Conference, Geneva, Switzerland.)*



United Kingdom's fusion apparatus "*Minni*" displayed at "Atoms For Peace" Conference in Geneva. *(U.K. exhibit, "Atoms For Peace" Conference, Geneva, Switzerland.)*



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(*Left*) Scientist shows visitor the experimental boiling water reactor which can provide up to 5000 kW of electricity to help meet the world's anticipated power needs. (*U.S. exhibit, "Atoms For Peace" Conference, Geneva, Switzerland.*)

a murder has indeed been committed, and can even be said to have discovered the corpse in the library. He has shown that perhaps there are a few tenuous clues which may take the investigation a few steps further, but we are a long way from the solution of the mystery. However, this very readable book, by drawing attention to the problems, will enable both professional and amateur entomologists to continue to work together and to make the sort of observations which must eventually solve the present difficulties. It is encouraging to find in these days that such co-operation can still be so fruitful. K. MELLANBY

Pioneering in Industrial Research: The Story of the General Electric Company

By Kendall Birr (*Washington, D.C., Public Affairs Press, 204 pp., $4.50*)

Dr Birr, an historian, has produced a very readable history of the General Electric Research Laboratory at Schenectady, N.Y. It is an institutional study "designed to offer a detailed picture of the operations of an exceptionally successful research institution".

The story of the G.E. Laboratory is fairly typical of that of a number of large industrial research laboratories, especially those of commercial undertakings that are of such size that the research laboratory is not by any means the only laboratory in the company.

In this case it was not even the first laboratory within G.E., and this may have contributed to its undoubted success because it did not get bogged down in a mass of trouble-shooting, as has happened in many other cases. This does not mean that the laboratory was engaged purely on fundamental work, but its programme was carefully balanced.

A useful first chapter on the "Roots of Industrial Research" traces briefly the growth of research patterns in the U.S.A. and various European countries. This provides a background for a fuller consideration of the origins, growth, expanding interests and fundamental policies of the main subject.

The author points out that research directors have always played a key role in the development of research laboratories and that some organisations have fallen into obscurity when they have failed to replace a highly successful director.

The outstanding personality in the formative years of the G.E. Laboratory was Willis R. Whitney, who was its director for over thirty years. Other outstanding names of this period are Irving Langmuir, W. D. Coolidge, and Saul Dushman. No doubt, the commanding position of one man is less in the very large organisation of today, but Whitney's belief that a good research scientist is the key to successful research is axiomatic and applies whatever the size of the organisation.

Dr Birr's book gives an interesting account of some of the highlights of G.E. research and, whilst it indicates the effect that these discoveries have had upon the development of the company, the author comes to the conclusion that it is impossible to make any specific evaluation of the work in terms of company turnover.

In discussing the success of the laboratory, Dr Birr stresses the fact that its fundamental researches paid off in part because they were carried out for a company with broad technical interests and strong financial status, able to exploit those discoveries commercially, and from this he draws the general conclusion that the success of an industrial research laboratory is dependent, in considerable degree, on the skill and resourcefulness of other branches of the company for which it does its research.

All those who have watched American TV will have seen programmes sponsored by the General Electric Company, and will have heard many times their slogan, "Progress is our most important product." This accords well with the general impression gained from reading this book that the G.E. Research Laboratory's principal foundations are those of encouragement of scientific curiosity, freedom, and co-operation. E. S. HISCOCKS

Three Steps to Victory

By Sir Robert Watson-Watt (*London, Odhams Press, 1957, 480 pp.+25 plates, 30s.*)

This book is unusual in that it is a combination of an autobiography and a documentary description of radar and its application as a military weapon. In these days of advanced television, jet aircraft, nuclear power-stations, and artificial earth satellites, the modern generation takes radar for granted. This book will serve to remind the older generation of the important consequences of basic research and experiments conducted a quarter of a century ago, and to make the younger readers acquainted with the man who was undoubtedly responsible for much of the success which accompanied the introduction of radar as an aid to both defensive and offensive tactics in the 1939–45 war.

The "three steps to victory" are the invention of the cathode-ray direction finder, originally conceived and developed for the simple purpose of determining where thunderstorms were occurring; the demonstration of radar, already in use for the scientific investigation of the ionosphere, and its development into a military weapon that revolutionised the art and practice of war in the air, at sea, and on the ground; and thirdly, the use of operational research as a means of assessing on the field of war the results of various military activities, and the application of the results to new tactics and weapons. There is no doubt that these three steps, supplemented by much detailed development and by other applications of scientific progress, were decisive in the contribution towards the ultimate victory.

The first few chapters of the book described the author's early life, his education and post-university experience in the Meteorological Office and later in the Department of Scientific and Industrial Research. It was in the latter department's Radio Research Station that radar was born. A demonstration was given on February 26, 1935, by A. F. Wilkins (the author's closest and most active colleague in all the early work) of the possibility of detecting aircraft by reflection of radio waves. This experiment was made, however, merely to confirm the sound basis of a memorandum, reproduced as an appendix in the book, which is regarded by the author "as marking the birth of radar". From this point, the book describes the trials, tribulations, and successes which accompanied the conversion of an interesting technique into a practical application with the tools and equipment operated entirely by military personnel.

The story is related from the vantage point of reviewing events after they occurred, but it is supported by references to published and unpublished material, and also to conversation in high places. To some readers the book may appear to be egotistical, but it should be remembered that this is an autobiography as well as a kind of history of the subject. The book is rather long for the "Plain Man", for whom it is ostensibly written, but the text is relieved by a number of very interesting photographs of places and personalities associated with this story of radar. R. L. SMITH-ROSE

Chemistry Magic

By Kenneth M. Swezey (*London, Nicholas Kaye, 1957, 180 pp., 17s. 6d.*)

Much of the material for "this handbook of easy-to-do experiments" is culled from *Popular Science Monthly* and the mode of presentation is characteristically American. It is designed to provide the amateur chemist with a series of experiments, most of which are more immediately related to everyday life than those normally used for elementary teaching purposes. This objective is reasonable enough, but the author has not overcome all the inherent difficulties. The beginner, at least in

Britain, is not likely to be willing, or even able, to purchase the expensive range of apparatus—such as reflux condensers—and chemicals that is recommended, nor is he likely to make much of the perfunctory discussion of the basic principles involved. The more advanced student may possess, or have access to, the paraphernalia and may also have adequate background knowledge. But he would then also be able to use any of the standard textbooks of practical chemistry, over which this seems to have no obvious advantage. It is therefore rather hard to see to whom this book might be useful.

T. I. WILLIAMS

Linear Equations, by P. M. Cohn, *viii+74 pp.*

Sequences and Series, by J. A. Green, *viii+78 pp.*

Differential Calculus, by P. J. Hilton, *viii+56 pp.*

Elementary Differential Equations and Operators, by G. E. H. Reuter, *viii+67 pp.* (*London, Routledge & Kegan Paul, 1958, 5s. each*)

These books are the first four of the "Library of Mathematics"—a new series of short textbooks under the editorship of Walter Ledermann, "primarily intended for readers who study mathematics as a tool rather than for its own sake". In each one the writer has a very restricted field, and the aim is to present practical techniques with a theoretical discussion which is not pursued unnecessarily far. When it is not feasible to give a fully rigorous treatment the essential results are stated, and an explanation is given of why the proof is omitted. All of the books contain examples with solutions, and are to be praised for giving a rather fuller commentary on the reasons for the steps than is customary in many texts.

P. M. Cohn develops the solution of simultaneous linear equations by successive eliminations and presents a method of practical utility together with the accompanying general theory. This approach introduces many of the notions of linear algebra in a very natural and feasible way, and avoids the slavish dependence on Cramer's rule which prevents so many students from getting any deeper understanding of the subject. In fact, as in some other modern presentations, matrix theory is developed extensively before determinants are even mentioned. The concluding chapter on determinants is rather condensed, and the non-specialist student will certainly require more practice with simple examples before he can master the general theory as it is given here.

J. A. Green's account of sequences and series takes the theory as far as integrating and differentiating power series. The general results on this are stated without proof, but some particular cases are investigated completely from first principles. Uniform convergence is outside the scope of the book. The treatment is straightforward and easy to follow. Good features are the careful study of remainders and the inclusion of many numerical examples which show the order of numerical accuracy which may be obtained by summing the first few terms.

In "Differential Calculus" P. J. Hilton starts from the very beginnings of the subject and goes as far as Taylor's Theorem. He covers the basic foundations in great detail, and tries particularly to avoid the initial misconceptions which students can so easily form.

The book by G. E. H. Reuter describes techniques based on an operator Q, the integral from 0 to t, which will solve linear differential equations with constant coefficients under given initial conditions. There is a good section on linear operators in general and the algebraic technicalities involved in solving problems are very fully described; but many will feel that the particular form of operator chosen is not the best to teach students in the long run. In this subject it is fatally easy to give the impression that mathematics is merely a set of particular tricks for solving particular problems, and there is need for a book explaining the physical basis underlying integral transformations and their applications. This task the writer does not attempt.

The present drive for scientists and technologists means that more and more students with no great aptitude for mathematics need training in its techniques. Specialist students can always, if need be, look after themselves, but non-specialists require good teaching, and the effectiveness with which we teach them is one of the limiting factors on our technical progress.

The best methods will only be found by continued experiment, and it is good to see this series of books, devoted to one possible approach, being developed in a systematic way.

T. J. FLETCHER

Das Wunder Menschenhirn
(The Miraculous Human Brain)

By Alfred Mühr (*Alfred Verlag W. Germany, 1958, Olten und Freiburg/B., Demy 8vo, 464 pp., DM 26.50* [*approx. £2 12s. 6d.*])

This is a remarkable book on several counts; one soon understands why it took twenty years to complete. It recounts the truly adventurous history of brain research and resection from the early days of Hippocrates (4th century, B.C.) to modern practices of lobotomy.

Moreover, psychoanalysis and the interesting psychophysical implications of brain diseases are discussed; the problem of the genius and the insane, phrenology, the effects of civilisation upon primitive and modern man—these are but a meagre selection of chapter headings. In this feast of offerings, we are also led to closer understanding of our thinking processes, explanations are proffered of W. Jauregg's famous malaria therapy for paralysis (Nobel Prize 1927), and a host of beautiful illustrations is given. A useful medical glossary, a wide bibliography, and a comprehensive index remind us, as indeed does the readable style throughout, that this is not merely a highly important work for the medical student, but also for the general intelligent reader. It would merit immediate translation.

J. VORNE

Science News 48: Rocket and Satellite Research Number

(*Penguin Books, May 1958, 142 pp., 16 pp. of plates, 2s. 6d.*)

Space Unlimited: Satellite launchings by the U.S.A. in connexion with the IGY

(*United States Information Service, 24 pp. gratis*)

October 4, 1957, the day on which the Soviet *Sputnik I* was launched, was a great day not only for scientists but also for mankind. Later launchings, both by the Russians and the Americans, have shown that these events can occur quite frequently, and now equally spectacular advances are being promised for the near future.

A lot of us have much to learn. Those of us who will have nothing to do with "space-fiction" from H. G. Wells onwards must now reorient our thinking. Considerations of secrecy in the last decade have prevented scientific journals from giving us a steady flow of authentic information about the principles and performance of upper-atmosphere rockets, but now most of us must read and learn quickly. Rumours and guesses in daily newspapers are easily forgotten, but suddenly we find that a whole new subject has been developed behind locked doors. We find we are completely ignorant of even the application of the basic physical principles and search for an acknowledged scientist to lighten our darkness.

Penguin Books have come to our aid. Science News (No. 48) is entirely devoted to rocket and satellite research, and for the price of a luncheon voucher we can begin to get rid of that ignorant feeling. With opening and closing chapters by Prof. H. S. W. Massey, F.R.S., who writes

Advertisement

THE AMAZING POTENTIALITIES OF MEMORY

I little thought when I arrived at my friend Borg's house that I was about to see something truly extraordinary, and to increase my mental powers tenfold.

He had asked me to come to Stockholm to lecture to the Swedes about Lister and other British scientists. On the evening of my arrival, after the champagne, our conversation turned naturally to the problems of public speaking and to the great labour imposed on lecturers by the need to be word-perfect in our lectures.

Borg then told me that his power of memory would probably amaze me—and I had known him, while we were studying law together in Paris to have the most deplorable memory!

So he went to the end of the dining-room and asked me to write down a hundred three-figure numbers, calling each one out in a clear voice. When I had filled the edge of an old newspaper with figures, *Borg repeated them to me in the order in which I had written them down and then in reverse order, that is beginning with the last number. He also allowed me to ask him the relative position of different numbers: for example, which was the 24th, the 72nd, and the 38th, and I noticed that he replied to all my questions at once and without effort, as if the figures which I had written on the paper had been also written in his brain.*

I was dumbfounded by such a feat and sought in vain for the trick which enabled him to achieve it. My friend then said: "The thing you have just seen and which seems so remarkable is, in fact, quite simple; everybody has a memory good enough to do the same, but few indeed can use this wonderful faculty."

He then revealed to me how I could achieve a similar feat of memory, and I at once mastered the secret—without mistakes and without effort—as you too will master it tomorrow.

But I did not stop at these amusing experiments. I applied the principles I had learned in my daily work. I could now remember, with unbelievable facility, the lectures I heard and those which I gave myself, the names of people I met—even if it was only once—as well as their addresses, and a thousand other details which were most useful to me. *Finally, I discovered after a while that not only had my memory improved, but that I had also acquired greater powers of concentration; a surer judgment—which is by no means surprising since the keenness of our intellect is primarily dependent on the number and variety of the things we remember.*

If you would like to share this experience and to possess those mental powers which are still our best chance of success in life, ask O. F. Borg to send you his interesting booklet "The Eternal Laws of Success"—he will send it free to anyone who wants to improve his memory. Here is the address: *O. F. Borg, c/o Aubanel Publishers, 14 Highfield Road (Rathgar), Dublin, Ireland.*

Write now—while copies of this booklet are still available.

L. CONWAY

about the physical properties of the upper atmosphere and the present and future prospects of upper-atmosphere research, readers may rest assured that they are not being hoodwinked by charlatans. W. N. Neat writes about rocket motors and propulsion, and his article, being simple and lucid, sometimes has a mathematical beauty about it. W. H. Stephens and A. W. Lines write about guidance, control, and instrumentation; they compare the British *Skylark* and the American *Vanguard* rockets, and show the relationship between their apparently independent properties. "High Performance Rockets", by K. W. Gatland, is a useful account of the growth of the rocket family, which also contains a discussion of the problems of high-speed re-entry into the atmosphere. R. L. F. Boyd's chapters, "Satellites for Research" and "The Rocket-Borne Laboratory" are most useful summaries of the information which can be telemetered back to the ground. These two chapters also discuss the characteristic motions of satellites and rockets and the physical properties of the atmosphere which can be inferred from observing them. To those who work on the "B" side of the sciences, P. Howard's introduction to space medicine is both informative and humorous. There are also 16 pages of interesting photographs and a table giving the properties of the various rockets. Penguin Books and their Science News editors are to be congratulated on producing such a useful summary at the right moment.

The United States Information Service have published the booklet "Space Unlimited". Its photographs and coloured covers make it attractive for use in schools where the senior pupils will need to get a firm grasp of the advances going on around them, some of which were demonstrated by Isaac Newton. A. F. MOORE

"W.O.": The Autobiography of W. O. Bentley

(*Hutchinson & Co., Ltd, 1958, 224 pp., 21s.*)

In all the long history of sports cars and motor racing, no name is so well known or revered as that of the Bentley. No car before or since has surpassed the achievements of this make, which included three magnificent victories in the gruelling Le Mans 24-hour race. It is no exaggeration, therefore, to say that in the design of his masterpiece, which, with its four valves and two plugs per cylinder and many other novel features, placed his car a quarter of a century ahead of its contemporaries, Walter Oliver Bentley made a significant contribution to the science of automotive engineering.

Throughout this autobiography, one savours the dashing carefree atmosphere of the roaring twenties, the era of the Bentley Boys, of Sir Henry ("Tim") Birkin, and the inimitable note of those full-throated hand-made cars. In the pages of this fascinating book one receives the impression of "W.O." dedicated to designing and racing his cars, but nevertheless being inextricably involved in the chequered history of Bentley Motors Limited, pleasantly and modestly surprised by the success his cars achieved and equally resigned to the financial crises through which his Company passed before its final winding-up and disposal to Rolls-Royce in 1931.

Although these are pages of past glories to be read and enjoyed by all lovers of the thoroughbred sports car, "W.O." 's prowess as a designer was not lost. Not only are many of the original Bentley features incorporated in the present-day version of that car, but following the demise of the old Company, "W.O." 's genius for design was seen again in the Lagonda V.12 car.

Today the name of the vintage Bentleys lives on through the vigorous activities of the Bentley Drivers' Club of which "W.O.", now nearing 70, is the very active Patron. J. A. G. CROXON

The Physiology of Fishes

Edited by Margaret E. Brown, *New York (Academic Press Inc., 1957, vol. 1: "Metabolism", 447 pp., illustrated; vol. 2: "Behaviour", 526 pp., illustrated, $14 each)*

Fishes are the most diverse of the vertebrate animals. This is overwhelmingly due to one group of bony fishes, the teleosts. Since early Cretaceous times they have undergone astonishing evolutionary radiations. Today these fishes are to be found in a very wide range of surroundings: from warm springs to polar waters; from tide pools down to abyssal regions of 7000 metres; from ponds down to the bottom of Lake Baikal, and so on. The other modern bony fishes are merely the relics of groups that must have been ousted by the teleosts. The cartilaginous fishes are still relatively diverse, being represented by about 600 species of sharks, rays, and chimeras.

The extraordinary adaptive range of these animals is one of their attractions for the physiologist. But apart from the inaccessibility of many of them, fishes are not easy subjects for experimental work. As Dr Brown mentions in her preface, it

is probably due to this difficulty that fish physiology is not so advanced as that of mammals and insects. Yet knowledge is growing quite rapidly and is certainly extensive enough to justify this series of surveys.

The first volume deals with respiration, the cardiovascular system, the alimentary canal and digestion, excretion and osmoregulation, skin and scales, endocrine organs, gonads and reproduction, early development and hatching, growth and biochemical composition.

The second volume has sections on the nervous system, sense organs, behaviour, the swim-bladder, electric organs, luminous organs, pigments, colour change, water requirements, and physiological genetics. Each chapter or part of a chapter takes the form of a biological review and is written by a specialist.

A good standard has been maintained throughout. The authors not only review and synthesise present knowledge, but in many instances point out future lines of work. The uneven content of fish physiology is indicated by the fact that no space is given to the muscular system. Little is known, for instance, of the precise changes of form in the lateral muscles during swimming. The movements of cartilage, bone, and muscle during feeding also need investigation. Lastly, these studies would have been enhanced by an outline classification of fishes, showing the position of the many species that have been studied.

However, these two volumes will surely be welcomed by all who are in any way involved in the study of fishes. While the value of this survey will only be fully revealed in the future, we may confidently anticipate that the tasks of Dr Brown and her collaborators will have been well worth while. N. B. MARSHALL

Peter and Caroline: a Child Asks about Childbirth and Sex

By Sten Hegeler; drawings by Gerda Nystad; foreword by W. C. W. Nixon, M.D., B.S., F.R.C.O.G., Professor of Obstetrics, University of London (*London, 1957, Tavistock Publications, v+30 pp., 17s. 6d.*)

Prof. Nixon rightly observes that a child's questions about sex are to be answered clearly and accurately but simply and without answering more than is asked. He wisely suggests that parents may deal with their own embarrassment by discussing it freely with each other beforehand. The book provides answers with illustrations that will be acceptable and unalarming for children and for parents. The first time the question is answered with great simplicity; later in greater detail. Older children can well have access to the book whenever they wish to refresh their knowledge.

The book is well done and conveys something of the happiness we hope our children will find in this aspect. Some of us find it disturbing that when our children go to primary schools they pick up not only a Cockney speech (which does not matter), but a sniggering prudishness, which seems a pity. No one in his senses would wish to take laughter away from sex, but guilt turns laughter into sniggers. The text, pictures, and format of this book will lend support to the better general attitude to sex that we are trying to provide at home. R. MACKEITH

Brief Notes

H.M. Stationery Office have published the quarterly journal of the Colonial Products Laboratory, *Colonial Plant and Animal Products*, vol. 6, No. 2, 1956 (6*s.*). The journal contains two articles and two reports of investigations of the Colonial Products Laboratory.

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Autumn Television

Now that the longer evenings are with us again, the BBC has reintroduced another series of "Eye on Research"; the first broadcast was given on September 30, and it told the story of the virus. In a sense this was a new venture for it was produced by no less than four producers, Messrs Wright, Millett, Latham, and Rees, and this must surely be most unusual in any television broadcast. As before, the series will be edited by A. E. Singer, and if it maintains the level set up by this first broadcast, we can certainly look forward to some admirable programmes in the future, for this first broadcast was delightful, educative—indeed absorbing.

There were several novel features in connexion with the production. We had interviews and film from a variety of laboratories and the whole was knit together in an easy manner by a reporter, new to science, namely Raymond Baxter, who is so successful a commentator on motoring matters. Mr Baxter in fact turned out to be the perfect reporter. He had a complete grasp of all the difficulties the layman might be expected to have when confronted with such obscurities as x-ray crystal structure, or the electron microscope, and he asked just the right leading questions in just the right places. He was by far and away the best commentator the BBC has yet found as a general go-between for interpreting up-to-date scientific research to the man in the street.

The programme opened with an introductory film showing varieties of virus disease in man, animal, and plant, and Mr Baxter focused attention on the problems associated with the small size of the virus. He first interviewed Dr Markham of the Cavendish Laboratory, Cambridge, and made excellent recapitulations of the statements of the scientist. We were then taken over directly (live broadcast) to the Brussels Exhibition, where Dr Klug of Birkbeck College, London, gave a clear exposition of the formidably difficult matter of the complex structures of viruses, illustrating his talk with the remarkable huge models installed at the Brussels Exhibition. We were then switched back to the Cavendish Laboratory, where Mr Horne and Dr Brenner described the difficult techniques whereby magnifications of $\times 80{,}000$ can be used on virus and phage. Dr Brenner gave an excellent account of the life-cycle of a typical virus and he used some admirable animated diagrams to illustrate the dynamics of multiplication of viruses. In a brilliant short exposition he made it perfectly clear even to the completely uninitiated that the bacteriophage is essentially a genetic parasite.

This section was followed by a short interpolation from the Max Planck Institut, Tübingen, Germany, in which Drs Schramm and Shaeffer briefly reviewed their work on the separation of the constituents of viruses. This was perhaps not as satisfactory as the remaining part of the broadcast.

One thing vividly struck your reviewer, and that was the relative youth of most of the eight contributors to this programme. This is the first time that the younger active scientist has effectively domineered such a programme, for we have been used to seeing authoritative leaders in most analogous broadcasts. This encouragement of the younger active research worker is admirable and it certainly worked excellently, a tribute no doubt also to careful production. There was practically no example of the use of unqualified technical phraseology. This is a notable improvement, for many earlier science broadcasts have suffered from a deplorable use of technical terminology.

This was excellent television, live, dramatic, well produced and well linked. We hope that we shall see more of Mr Raymond Baxter as a science reporter, and we look forward with much interest to more science broadcasts of this quality. It was notable both for the quality and quantity of material successfully put across.

School term has begun, and with it active schools television projects have been initiated both on the BBC and the ITV channels. The ITV authorities have announced a very comprehensive scheme and, according to the *TV Times*, no less than 580 schools are taking their programmes. In some programmes, for example Art, children will be in the studio, and it may be mentioned that your reviewer has previously here pressed that a whole class ought to be televised; the camera should be placed as though it were one of the back row of a class and thereby heighten the illusion of a real school lesson in progress. Perhaps this will yet be tried out.

It is regrettable that ITV seem to be slipping into the easy way out by often broadcasting nothing but film with a phantom voice in the background. There will be a succession of nine programmes on Tuesdays (September 30 saw the first) designed to show life along a river bank. The choice has been La Dordogne, which starts out from the Massif Central. It is frankly admitted that the whole course is a succession of film, and to judge from the first broadcast, which dealt with the mountainous character of the source, it is likely to be excellent film. But the *exclusive* use of film is a failure to exploit the *personal* contact which is the very soul of television. Of course it can be argued with much justification that film, and film only, can be of great use in geography. This is plausible and perhaps acceptable, but there is little justification for the *exclusive* use of film in the physical sciences. For instance, Monday, September 29 saw the initiation by ITV of a new series, "Matter in Use", and it was subtitled "The Bricks and Mortar". The series is edited by J. Richmond and J. Frankau, research by C. Warren, illustrations by K. James, and direction by J. Frankau. The narrator was A. Sheppard, and the programme was prepared by A. Royds. The subject was an effective review of adhesion, cohesion, and tenacity.

The programme began well with a film shot of a child building sand-castles, following through to microscope film of sand-particles. A good deal of time was devoted to an explanation of the meaning of molecules and, having reached this stage, the difference, in terms of cohesion, between gases, liquids, and solids was discussed. The material was taken at a slow, steady pace. There were occasional minor infelicities. For instance, it is not quite helpful to say that a woodpecker is separating the molecules of wood when he pecks, nor is it quite correct to say that a pattern scratched on glass by a diamond is "etched" on the glass, but perhaps such minor verbal inaccuracies are hardly worth comment.

The main, and surely justifiable, criticism is that from beginning to end the whole broadcast was merely dubbed film; not once did a teacher appear, it was a succession of film shots tied together by a phantom voice. That ITV need not be tied to such a procedure in schools broadcasts was in fact shown by a completely opposite approach on October 1, when a school programme, "Process of Law" was admirably conducted by Jeremy Thorpe; very much a programme with the personal touch of the live broadcaster, and one which showed up only too well the relative poverty of a pure film broadcast.

This science broadcast can, however, be criticised on another more general ground. It aimed at far too general an audience. The content was good in a way,

but it was much more an *entertainment* than a *lesson*. There is a terrible danger in this, for it is only too easy to put across facile entertainment which interests but hardly educates. The larger the age-range aimed at the more wasteful is the broadcast likely to be. It is axiomatic amongst educators that it is useless to pitch material at too low a level. It would be better to aim specifically at narrow age-ranges, but this of course implies more than one broadcast. Here we come to a really formidable criticism of ITV, for each broadcast is put out at 2.45 p.m. and then *identically repeated* an hour later. Surely this is a shocking waste of that most precious of commodities, camera time. Clearly from the viewpoint of economy, the right thing is for the two periods to have programmes for different age-levels.

BBC have also begun most ambitious schools broadcasts, especially in mathematics and in biology. It is hoped to review the extensive scheme published for October in a later report. S. TOLANSKY

Research Film Show—B.A. Glasgow, 1958

For the fourth successive year the Scientific and Technical Group, in conjunction with the Scientific Films Committee of the British Association, presented a series of research films as part of the annual meeting of the British Association. These films were shown in two sessions during the morning and afternoon of Saturday, August 30th, 1958. The morning session was under the chairmanship of Sir Raymond Priestley, and during the afternoon Mr Bowler, vice-president of the Royal Photographic Society, took the chair.

Several films were devoted to biological subjects, from the study of the mating behaviour of marsupial frogs to the study of cancerous cells. The muscle structure of sea-anemones, courtship of *Drosophila melanogaster*, nematodes, and *Leishmania donovani* were also objects of investigation. In what might be described as the industrial field many problems had been covered with cine-techniques, including the casting of steel, coke-oven performances, vehicle suspension systems, flooring research, bookbinding operations, and the flow of water in large pipes.

From the psychological aspect, two films were shown which demonstrated techniques which have been employed to identify the particular point of a general scene at which a subject is looking, thus enabling eye co-ordination to be studied. Also in this field, an extract was shown from a film which studied parent-child relationship in an experimental treatment of the problems involved in admission to hospital of children under school age.

In pure physics, the motion of electrons in electric fields was demonstrated by means of charged droplets, this film being made in Germany. Automatic self-replication was also shown by ingenious systems of models. Finally, Mr Hallett, Secretary of the Society, gave a short talk on the scope and aims of the "Encyclopaedia Cinematographica" with examples of research films loaned by Dr Wolf of Göttingen.

Among the methods used to prepare these films were time-lapse and high-speed cinematography, interference, and phase-contrast microscopy, electron microscopy, and television techniques. Colour and monochrome, silent and sound-track films were all represented at this meeting, which admirably demonstrated the wide variety of techniques by which cinematography can be of use in research in an equally wide range of scientific investigation.

400 Films from the Science Library of the British Film Institute

(*London, Scientific Film Association Special Issue of* Review, *3s. 6d.*)

As is well known, the Scientific Film Association in the bi-monthly issues of its *Review* has recently been giving annotated lists of films on special subjects such as Chemistry, Atomic Energy, Building, and so forth. The current issue is of particular interest, being a list of science films available from the Library of the British Film Institute.

At first glance the list looks curiously unbalanced, containing only four titles under Agriculture and thirteen under Chemistry, and at the other extreme nearly two hundred under Medicine. This, however, is a reflection of the function of the Library, for many films made by, or with the backing of, commercial undertakings, are distributed through their maker's libraries whereas the Institute provides facilities for the distribution of films made by independent workers such as those in university departments and in medical schools and also provides a source of films which are not otherwise available in this country; many of the films included under "Industrial Subjects" originated in the United States.

To have this up-to-date list is extremely useful and the Scientific Film Association and the British Film Institute are to be congratulated on their co-operation in its production. An introductory note explains that it is intended to form the basis of a new Institute catalogue and with this in mind a few suggestions can be offered.

Firstly, it is to be hoped that where they are at present lacking, full details of date of production and name of producer or scientific adviser can be added. Secondly, the detailed information given about the films varies widely, in some instances the contents are set out very fully but in others this information is meagre. We are not told whether the Institute will include in its definitive catalogue the SFA Reviews compiled by panels of expert viewers, and if this is the intention, it is to be hoped that all the films will eventually have this specialist evaluation. The same remark applies to the suggested audience suitability; some of the present suggestions could be strengthened by closer definition, for example "Physics students" is not very useful as compared with "Students of pure physics at undergraduate level". (Both these occur on p. 185.) Thirdly, it is to be hoped that cross-reference will be undertaken; for example under Cinematography (p. 108) there is a film entitled "Plant Movement"; it is included here because the technique of time-lapse cinematography is explained in some detail. However, some reference in the biological section to this film would be useful and in the biological section we find a film "Birth of a Flower" made by the late Percy Smith in 1910, its review says: "A historic film, for it is probably the first British example of time-lapse photography applied to plants." Surely there should be some reference to this under Cinematography.

Finaly, in reprinting the catalogue, opportunity will be presented for correcting various typographical errors, some of these are no more than irritating (or amusing?) such as p. 192, where we meet the word "cinematograhy", others might mislead, as at the last line of p. 161 where *Taenia echinococcus* is said to produce "hydrated disease in man" instead of "hydatid" disease. Attention to the points noted would make the list not only extremely useful (which it is already) but authoritative. G. E. H. FOXON

LETTER TO EDITOR

Science or Art

Sir:

With reference to your September issue in which you published the very interesting article about science and abstract art. . . . I must guess that you thought to make an invention by putting Klee's picture next to a technical one. By turning Klee's picture's name, "Air-Tsu-Din", you get "Ind-ust-ria", from which we may conclude, that Klee was the first one to see the relations between his picture and such as yours.

Yours truly,

A. DE KOOL

Nieuwe Rotterdamse Courant N.V.,
Rotterdam, Holland.

FAR AND NEAR

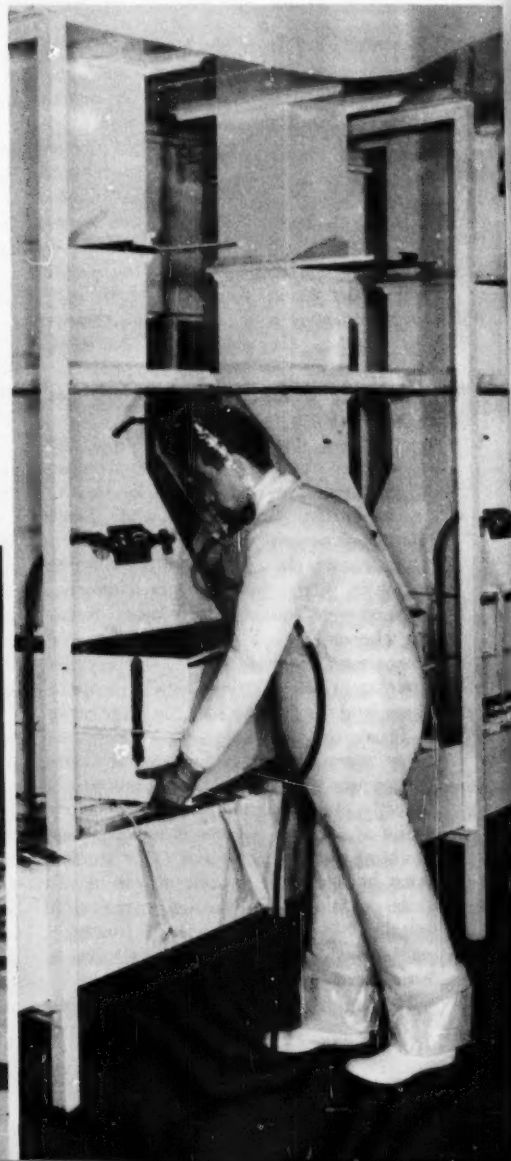
What Scientists Wear

In space research and underwater research man must take his environment with him. Our first illustration (*above left*) shows an explorer of today, Captain Earl G. Weaver, standing beside his Consolidated F-102A "Delta Dagger". He is wearing the high-altitude, partial pressure suit worn by pilots of this type of aircraft.

Our second illustration (*above right*), a Shell photograph, shows a diver inspecting flexible hose connexions to the 16-in. diameter oil "sealine" set up to speed the discharging and turn-round of tankers at St Vincent, Cape Verde Islands, by the Shell Company of Portugal Limited. Divers are continually at work at places where oil tankers take on and discharge their cargoes from a pipeline extended into the sea. The diving suit is a standard compressed air unit as developed by Cousteau.

Fig. 3 (*right*) shows an operator wearing a pressurised suit to protect himself against beryllium dust, changing a filter in the beryllium laboratory of the General Electric Company at Erith, Kent.

Finally, Fig. 4 (*below*) shows a demonstration being carried out at the Engineer Research and Development Laboratories at Fort Belvoir, Virginia, U.S.A. The firefighters are wearing special aluminium suits that are heat-resistant.



Science in Parliament: August 1958

With Parliament in recess, August 22 saw the publication of the report on the Department of Scientific and Industrial Research by the Select Committee on Estimates. It is this Committee's duty, on Parliament's behalf, to scrutinise the estimates of government departments and to ensure that projected expenditure is justifiable.

The report, however, is not narrowly fiscal in character and many of its observations will be not unwelcome to the scientific community. Particularly gratifying is the Committee's awareness that in no area is the application of the scientific method more vital than in the determination of scientific strategy (see DISCOVERY, January 1958, vol. XIX, No. 1, p. 1); the systematic review of its establishments by the Department's own Council for Scientific and Industrial Research, and its application of economic and statistical techniques to evaluate research programmes from the national economic standpoint receive particular mention. On the debit side, though, is evidence of a cumbersome committee structure in scientific policy, with factual examples of defective liaison and overlapping. Two areas attracted particular attention: the Committee emphasised that there could be a more efficient research effort if the Road Research Laboratory were transferred to the Ministry of Transport—the Laboratory is hampered because it is only rarely shown contracts for road construction by the Ministry; there is similar one-way traffic between the Admiralty and the National Physical Laboratory regarding research into ship and propeller design—while the Admiralty is kept fully informed of the Laboratory's relevant programme, the reverse, apparently for security reasons, is not the case, and the Committee urges the two Departments to plan the use of scarce research facilities jointly.

Another important facet of the Department's activities is the provision of grants, currently approaching £2 million per annum, to co-operative industrial research associations. Their significance may be measured by the Department's estimate that these research organisations serve about 55% of manufacturing industry; nearly 30% rely on their own resources, private organisations or government stations, while 18% of industry have not the "right" facilities. Though hampered by the varying outlooks and levels of efficiency of firms within industry, the associations are succeeding in making industry more research-minded. Concrete achievements by the associations include a cut of one-third in laundry soap-consumption, the development of the convector-fire by the British Coal Utilisation Research Association and, for the leather industry, the saving in twelve months of five times the amount spent on research over many years.

Financial recovery of the costs of research is a vexed problem. Whereas industry contributes extensively to the research associations and thereby to the benefits derived, the Committee is concerned that industry does not bear an adequate share for the services of DSIR establishments, though remedies are foreshadowed.

Finally, the report spotlights the DSIR's important role in sponsoring research at the universities and especially in providing grants for one-third of all post-graduate science students. Even so, if such studentships were granted to all suitably qualified applicants, the Department would perhaps have to support as many as double the present number.

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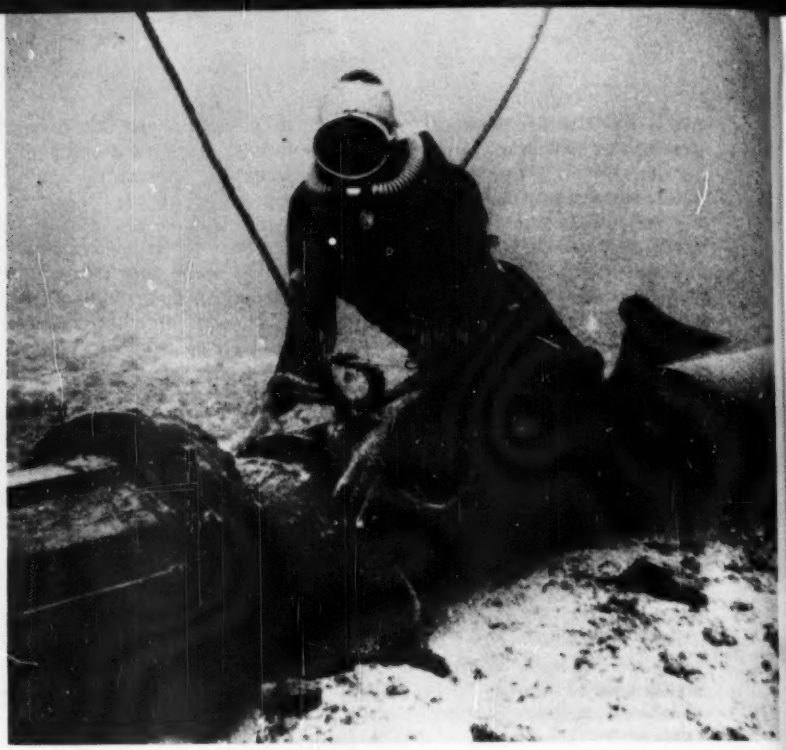


FAR AND NEAR

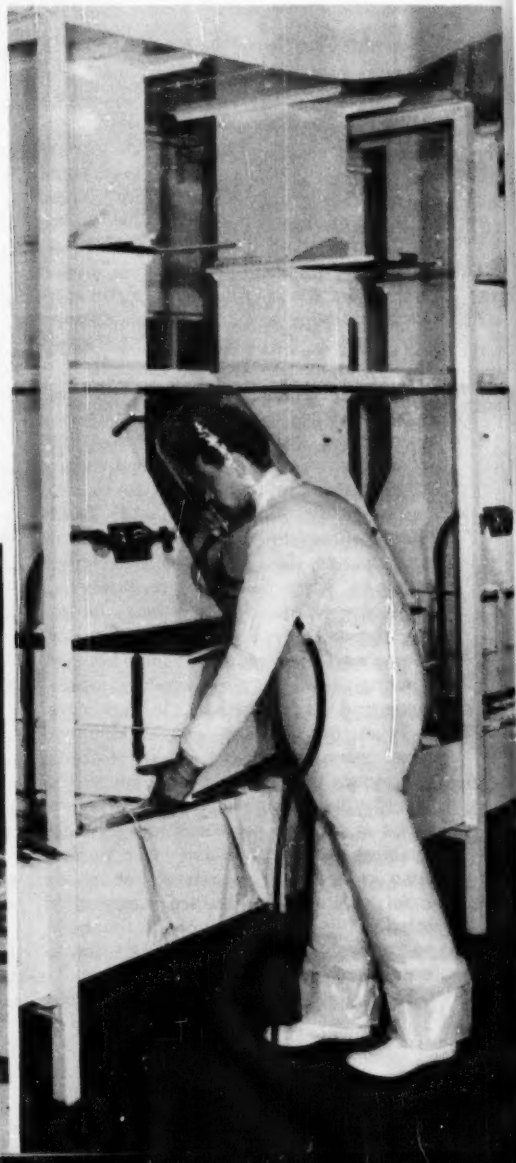
What Scientists Wear

In space research and underwater research man must take his environment with him. Our first illustration (*above left*) shows an explorer of today, Captain Earl G. Weaver, standing beside his Consolidated F-102A "Delta Dagger". He is wearing the high-altitude, partial pressure suit worn by pilots of this type of aircraft.

Our second illustration (*above right*), a Shell photograph, shows a diver inspecting flexible hose connexions to the 16-in. diameter oil "sealine" set up to speed the discharging and turn-round of tankers at St Vincent, Cape Verde Islands, by the Shell Company of Portugal Limited. Divers are continually at work at places where oil tankers take on and discharge their cargoes from a pipeline extended into the sea. The diving suit is a standard compressed air unit as developed by Cousteau.

Fig. 3 (*right*) shows an operator wearing a pressurised suit to protect himself against beryllium dust, changing a filter in the beryllium laboratory of the General Electric Company at Erith, Kent.

Finally, Fig. 4 (*below*) shows a demonstration being carried out at the Engineer Research and Development Laboratories at Fort Belvoir, Virginia, U.S.A. The firefighters are wearing special aluminium suits that are heat-resistant.



Science in Parliament: August 1958

With Parliament in recess, August 22 saw the publication of the report on the Department of Scientific and Industrial Research by the Select Committee on Estimates. It is this Committee's duty, on Parliament's behalf, to scrutinise the estimates of government departments and to ensure that projected expenditure is justifiable.

The report, however, is not narrowly fiscal in character and many of its observations will be not unwelcome to the scientific community. Particularly gratifying is the Committee's awareness that in no area is the application of the scientific method more vital than in the determination of scientific strategy (see DISCOVERY, January 1958, vol. XIX, No. 1, p. 1); the systematic review of its establishments by the Department's own Council for Scientific and Industrial Research, and its application of economic and statistical techniques to evaluate research programmes from the national economic standpoint receive particular mention. On the debit side, though, is evidence of a cumbersome committee structure in scientific policy, with factual examples of defective liaison and overlapping. Two areas attracted particular attention: the Committee emphasised that there could be a more efficient research effort if the Road Research Laboratory were transferred to the Ministry of Transport—the Laboratory is hampered because it is only rarely shown contracts for road construction by the Ministry; there is similar one-way traffic between the Admiralty and the National Physical Laboratory regarding research into ship and propeller design—while the Admiralty is kept fully informed of the Laboratory's relevant programme, the reverse, apparently for security reasons, is not the case, and the Committee urges the two Departments to plan the use of scarce research facilities jointly.

Another important facet of the Department's activities is the provision of grants, currently approaching £2 million per annum, to co-operative industrial research associations. Their significance may be measured by the Department's estimate that these research organisations serve about 55% of manufacturing industry; nearly 30% rely on their own resources, private organisations or government stations, while 18% of industry have not the "right" facilities. Though hampered by the varying outlooks and levels of efficiency of firms within industry, the associations are succeeding in making industry more research-minded. Concrete achievements by the associations include a cut of one-third in laundry soap-consumption, the development of the convector-fire by the British Coal Utilisation Research Association and, for the leather industry, the saving in twelve months of five times the amount spent on research over many years.

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Burlington Street, London, W.1, for application form, quoting (*a*) S.53/58, (*b*) S.52/58.

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